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HOW THE WORLD IS HOUSED

FRANK GEORGE CARPENTER



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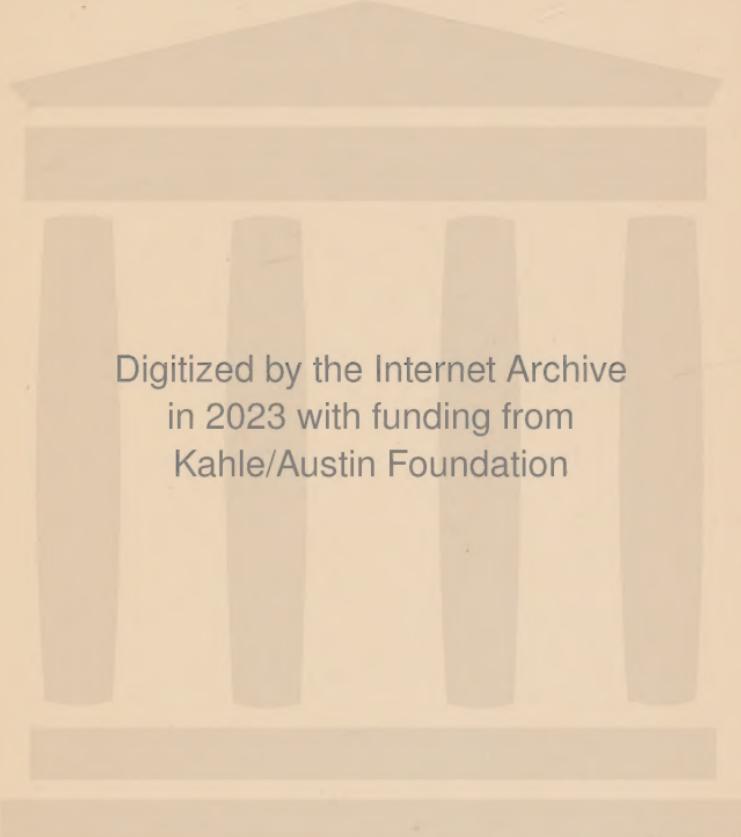
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183 READERS ON COMMERCE AND INDUSTRY
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HOW THE WORLD IS HOUSED

BY

FRANK G. CARPENTER

AUTHOR OF CARPENTER'S GEOGRAPHICAL READERS



NEW YORK :: CINCINNATI :: CHICAGO
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CARP. WORLD IS HOUSED.

E. P. 5

PREFACE

Food, clothing, and shelter are man's three great necessities. They are common to all races and tribes, to all localities, and to all times. The desire for them has formed the basis of civilization, and how far that desire has been satisfied is the chief criterion of the civilization which each people possesses.

For these reasons it is of great importance that we should know as much as possible about food, clothing, and shelter as they relate to ourselves and other nations. They are among the fundamental elements of all geographical study and are necessary to a knowledge of the earth as the home of man.

The acquisition of this knowledge is the object of the travels which the children accompanied by the author are supposed to take in the Carpenter Readers of Industry and Commerce. In the first book of the series, entitled "How the World is Fed," their travels are devoted to learning about the sources of our foods and how they are turned into the forms in which they appear on our tables. In the second book, "How the World is Clothed," the children go over the globe to investigate what the people wear and how it is made. The third volume is comprised of the pages which follow, and is devoted to "How the World is Housed." In this book the children travel over the globe to learn for themselves where the materials in their

homes come from and how they are prepared for use. They also study the homes of other countries, visiting their little world brothers and sisters and seeing how they live.

In each of these three books the travels are made along geographical lines, and the children, while studying the industries and home life of the various nations, learn to know the principal trade routes and other branches of the world of commerce. Their imaginary travels give them a live knowledge of many geographical features, thereby vivifying the study of their geographical textbooks.

In "How the World is Housed," the children are first taught the evolution of the house, beginning with the homes of the cave men and the tree shelters of the aborigines and ending with the enormous buildings of our modern civilization. They travel among the tent dwellers of the great desert countries, visit some of the people who still live in huts, and also those who have homes of grass, cane, and leaves. They peep into the odd houses of Asia and Africa, and see something of those of Europe and the other continents. They have a glance at some of the buildings of the past, and especially those of colonial times, and then take up the study of our homes of the present.

During their world-wide travels the children investigate the sources and manufacture of building materials. They go with the lumbermen into the forests and watch them chopping the trees and rafting the logs to the mills. They follow the logs as they pass through the band saws, planers, and other machines, coming forth in the shapes used in modern house building. At the same time

the extent of our lumber regions is shown, and also the important place which they have in our national wealth.

In other journeys the little travelers go down into the quarries from whence our marbles, granites, slates, and other building stones come; and learn how artificial stones, such as concrete, cement, and plaster, are made. They also visit the brickyards, and study the great part that clay has in our homes.

The next subject taken up is iron and steel as regards modern house building. To learn about this the children enter the mines, and follow the ore through the furnaces and rolling mills until it at last appears in the structural steel shapes of our great office buildings. They also see the metal turned into nails, screws, locks, and hinges. They then investigate tin and zinc as far as they are related to building, and afterwards learn about lead, copper, and brass. Other travels are devoted to glass, others to wood pulp and paper, and still others to paints, oils, and varnishes.

An important part of the book is that which treats of the heating, lighting, and water supply; and others are those showing the wonders of our factories, thereby giving the children some idea of the advantages of the civilization in which they live.

In writing this volume every attempt has been made to fill it with human interest and child interest without descending to the level of petty curiosity. It is a live book for the live, wide-awake American boys and girls of the present day, who are here traveling over the globe to examine things of real interest to them; and to study their world brothers and sisters as such, and as they are related

to and connected with them in the work of the world. It is believed that these many journeys will do much to give the children an idea of the earth as a whole, and of the relations which it has to the places upon it in which they live.

Acknowledgments are due to the Buffalo Sunday Illustrated Express, the Waldorf-Astoria Hotel, the American Radiator Company, Atlantic Terra Cotta Company, Atlas Portland Cement Company, Beal and Scott, Pittsburg Plate Glass Company, Post and McCord, Sherwin Williams Company, Standard Sanitary Manufacturing Company, and Yale and Towne Manufacturing Company for their courtesy in furnishing material for illustrations.

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HOW THE WORLD IS HOUSED

I. INTRODUCTION

THIS book is to be the record of the doings of a party of children who are to travel with the author over this big round earth. Each one who reads it is to imagine himself one of the party, and we are to go together over the oceans and across the mountains and plains looking at and learning about the world for ourselves. There will be so much to see that we must keep our eyes wide open. We shall carry cameras with us to photograph the most interesting sights, and our pencils and notebooks must be always at hand to write down the things we wish to remember and tell to our people at home.

We shall not travel without an object. The world is so large and it has so much to show us that we might spend our whole lives in journeying over it and not see it all. So it is best to take up one class of things at a time, and devote our journeys to that. In other books of this series we have already gone over the globe to learn how the world is fed, and how it is clothed. In our present travels we shall try to find out how it is housed. We shall peep into the dwellings of our little brothers and sisters of other races in different parts of the earth and see how they live. We want to know how their houses are made and

furnished. We would also learn as to our own homes and how they are constructed, and we shall go to the places from where the building materials come, and see how they are prepared for our shelter and comfort.

All this will require many long journeys. We shall travel over the various grand divisions, and explore many parts of them. We shall go into the mighty forests to see where the wood comes from; to the quarries to watch men getting out the granite, marble, and other building stones; and perhaps descend below ground to learn about the iron, copper, tin, and other metals used in putting them together. We shall visit factories and foundries of many kinds, and find that thousands of people all over the world are always at work in the industry of making our houses. We shall see the great part that commerce has to do with preparing the materials and bringing them to the places where they are required for building, as well as in erecting the structures. Our travels will therefore be along the two great lines of industry and commerce, which have so much to do with our own employment and comfort.

Before we start out, however, let us have a little talk about those people who lived long ago before houses, as we know them, existed. No one can tell just what was the first language spoken or just where was the first place on earth that man lived; and in the same way it is hard to say what the first house was like. We believe that all mankind were originally savages. They either went naked or dressed in skins or leaves, and in all probability their earliest shelters were the wide-spreading trees of the forests in which they lived. They crowded around the trunks

of the trees to keep out of the sun and the rain, and climbed into the branches to be safe from the wild animals that might attack them. In the winter they sought out caves in the rocks and holes in the earth on account of the cold, often driving out the savage beasts who had their homes there.

After a short time man learned to make shelters of branches covered with leaves or grass, and then to twist



Palm-leaf huts.

the branches together and chink them with mud into huts. He roofed these rude shelters with grass or the skins of the wild animals he was able to trap, and finally learned how to sew the skins into tents.

Indeed, there are many people now living in the more savage parts of the world who have shelters as rude as those of our own ancestors of long ago days. For instance, in the islands about the Strait of Magellan at the southern end of South America, I have seen natives who go almost naked. They have no villages nor fixed habita-

tions and move about fishing and hunting, making rude shelters wherever they stop. They choose a bushy spot, and, bending the branches together, tie them at the top. They then break off other branches and lean them against this framework, making a little tent about three feet high into which they crawl to sleep at night. Their food is fish and mussels and such small animals as they can trap and kill with their bows and arrows. They have no stoves and cook on fires in the open air. They are wild savages, and live but little better than beasts.

It is much the same with the tribes of black people who inhabit the wilder parts of Australia. They make their shelters by tearing off pieces of bark from the fallen trees and leaning them against one another. The pygmies of the great forests of the Kongo in the heart of Central Africa have no better homes. They are black dwarfs, so small that the full-grown men and women are no taller than American boys and girls of twelve and thirteen. They wear almost no clothing, and but few of them have permanent homes. Most of these little people travel about from place to place, sleeping upon the ground or in the branches of trees. Some of them dwell in caves, and others in rude huts of bark which they erect where they stop. A few of the tribes have villages or collections of such shelters.

The ordinary pygmy house is so low that we could hardly stand upright within it, and the entrances are such that the little owners themselves have to crawl in. It is usually of an oblong shape with two doors, one in front and one behind, so that the pygmies may run out at the back if attacked at the front. The houses are formed of branches

stuck into the ground, so that they lean towards one another. They are tied at the top, and the sides and top are rudely thatched with leaves and grass. They have no



A cave on the Island of Juan Fernandez.

furniture. The pygmies sleep upon the ground or on beds of leaves. They live upon roots, and by trapping and hunting, their weapons being bows and poisoned arrows.

Very similar to these people are our own little brown cousins, the Negritos, or black dwarfs of the Philippine Islands. They wander about from place to place, putting up shelters to sleep under when night overtakes them. They sometimes dwell in caves or holes in the rocks, and we may suppose that their homes are much the same as those of our race before it began to be civilized.

Caves have been found in England, France, and in other parts of Europe in which man once dwelt, and in them the tools of bone and flint which he then used. In some places our ancestors of the long-ago days cut homes for themselves out of the soft rock; and, even now, in the loess country of western China, there are people who dwell in similar homes. The soil there is many feet deep, and of such a nature that the streams and roads have cut deep ravines through it, the walls of which are almost perpendicular. In these walls the people have made rooms and fitted in doors and windows, forming dwellings which are comfortable and not at all damp.



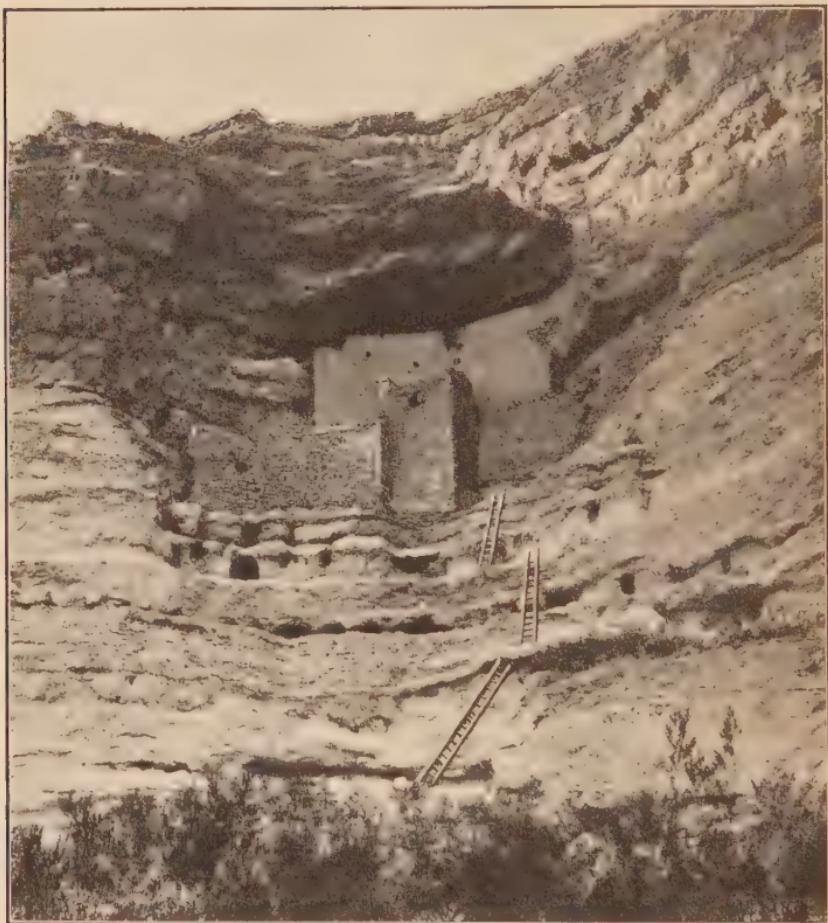
"In Tunis are tribes which have homes in the cliffs."¹¹

Not far from the Gulf of Gabes in Tunis, on the edge of the Desert of Sahara, are tribes which have similar homes in the cliffs. In the southwestern part of our country are to be found the remains of the Indian cliff dwellers, who lived in the crevices of the cliffs which they walled up with stone, and still farther south in Mexico are other cliff dwellers. In the northern parts of Alaska the Eskimos build their winter homes half underground, roofing them with snow, and digging passages below the earth through which they go in and out. In many newly settled countries the pioneers often use caves as dwellings until they can erect more comfortable homes, and there are now houses made of sod and clay in different parts of our West which are almost like caves.

Returning again to that long-ago time when men were but little better than savages, we may suppose one of them grew tired of his cave home or brush tent and tried to make a permanent shelter which the rain could not enter nor the wind blow away. To do this he piled up stones into rude walls, and made a roof of some kind above them, thus constructing the first hut or real house. His fellows did likewise, and step by step man discovered how to make the foundations, to improve the roofs, and to form the doors and openings for light and air.

The first tools were of stone, bone, horn, and wood. Later, as man learned how to work in metal, he made implements of copper and bronze and, after many ages, of iron and steel. As the tools became better the shelters steadily improved. The stones were cut into blocks and the trees chopped into logs. After a time smooth walls of stone or wood were constructed, and roofed with flat stones

or hewn boards and afterwards with shingles and slate. Then somebody discovered how to make bricks, and plaster and cement came.



Cliff dwellings in Arizona.

By and by the secrets of glassmaking were learned, and step by step invention marched along with industry until the rude huts became houses and the villages grew into cities. Civilized man then began to make temples and

palaces and mighty structures of every description. The work of improvement went on in small buildings as well as in great, until we now have our wonderful homes made of materials gathered by commerce from all parts of the world, and, by industry, so combined that they give us all the comforts and conveniences of modern life.

In our travels we shall find races and tribes who are now living in the many different stages through which man has risen in making a home for himself, and, by our imagination, can see how our ancestors lived when they were passing through these same conditions. Moreover, by observing the ruins left by the people of those long-ago days, we shall learn something of the houses in which they dwelt.

2. AMONG THE TENT DWELLERS

WE shall begin our journeys to-day by visiting some of the simpler homes of mankind. One of the first was the tent. It came into use during the early stages of civilization when man maintained himself largely by hunting and needed a shelter which he could carry with him to the spots where the game was most plentiful. Later on it became the home of those who lived by rearing cattle and sheep, the animals being driven long distances to the best feeding grounds. This was so in the days of the Scriptures. In Genesis we read that Jabal "was the father of such as dwell in tents, and of such as have cattle"; and that Abraham "sat in the tent door in the heat of the day."

The first tent was probably of leaves or skins sewed together, and stretched over a framework of poles, or the branches of trees. It may have been like the wigwams of poles covered with skins in which our Indians were living at the time that America was discovered, or the skin tents which now form the summer homes of the Eskimos in the northern parts of our continent. Skin tents are the dwellings of some of the natives of Siberia who travel about in their reindeer sledges, and also of the Mongols of the Desert of Gobi and the regions beyond the Great Chinese Wall. The latter have circular dwellings made of a framework covered with skins. Tents of skin are common in parts of Thibet, where yaks are used to carry them from place to place. They are also the homes of certain tribes of Hottentots, and other wandering African peoples.



Australian shelters.

The first cloth tent was probably of felt, somewhat similar to that now used by the nomads of Persia, or by the Kirghiz of western Asia. The Kirghiz have round tents



The Kirghiz have round tents on latticework frames.

of a considerable size. They are upheld by a folding latticework frame made of sections which can be opened and closed and therefore can easily be packed upon horses and carried to new grazing grounds. After this wooden framework is set up, a cover of thick felted cloth is spread over it, being stretched tight around the walls. It has a door at the front, and is fastened at the bottom with stones or pegs. The Kirghiz rear many horses and sheep, and their chief food is mutton and horse flesh, which they sometimes eat with mare's milk. They milk their mares as we milk our cows.

When man learned the arts of spinning and weaving, he made tents of wool, flax, and other fibers. As time went on his tent coverings became thicker and stronger, until at last was invented the tightly constructed waterproof

canvas which forms the material of the army tent of to-day. It is made chiefly of the fibers of hemp or flax, and is one of the strongest of cloths. Such tents are used by soldiers all over the world. When on the march each man carries upon his back a small one in which to sleep at night; but in camp he lives in the larger tents brought along in the baggage wagons. There are also large and well-equipped tents for the hospitals and for the officers.

In the past some of the tents used by the commanders were gorgeous. That of Alexander the Great was so big that one hundred people could sleep in it, its cloth roof being upheld by eight pillars plated with gold. Another famous Persian commander had a tent of red wool lined with violet satin beautifully embroidered. This was supported by poles decorated with carvings and inlaid with mother-of-pearl. The floor was carpeted with costly rugs, and the whole interior was furnished more like the palace of a king than the home of a rough soldier.

We take canvas tents when we go out to hunt and fish. They are to be seen at camp meetings, and are used by the circus people and others who carry shows about the country. They form the homes of engineers and their men when laying out and constructing railroads, and of all people who require temporary shelters.

The chief tent dwellers of the world, however, are nomads who live in Africa and Asia. They inhabit the arid regions of both continents; the Tatars, including the Kirghiz and Mongols, being found in parts of northern and western Asia, and the Arabs, Bedouins, and others living in the vast sandy wastes of the Sahara in Africa. There are also many tent dwellers in Arabia and Persia.

The life of these nomadic or wandering peoples is everywhere much the same. They are chiefly pastoral tribes who live by rearing horses, camels, cattle, sheep, and goats, moving about from place to place with their flocks to the best feeding grounds.

Suppose we visit some of the Arabs of the great Desert



Shepherds of the Sahara live in tent villages.

of Sahara. We have crossed the Atlantic Ocean and have passed through the Strait of Gibraltar into the Mediterranean Sea. Landing at Algiers we make our way over the Atlas Mountains down into a region which is almost all bare rock and sand. There is a scanty growth of coarse grass here and there along the edge of the desert, and in the valleys or beds of its rivers and streams which are dry the greater part of the year. At long distances apart

are the oases, patches of green in the midst of sand, watered only by springs or underground streams. In some of the oases are villages and in the larger ones cities or towns.

The Arab tent dwellers live out in the waste. They move about with their flocks and herds, feeding at each green spot until the grass is all eaten and then going on to new pastures. Owing to the sparseness of the vegetation they cannot have fixed habitations. It does not pay them to build houses at each stopping place, and they must have portable dwellings which they can take down and put up as they wish.

The Sahara is a wild country, and many of its inhabitants are fierce men who prey upon their fellows. Therefore the shepherds travel about together in order that they may be able to defend themselves and their stock against robbers. They live in little tent villages, to which as night falls they drive their camels, sheep, and goats.

We are surprised at the extent of the Sahara. If that great desert could be lifted up like a quilt and spread over our country it would cover every bit of it and hide a part of Canada and the Gulf of Mexico. It is bigger than all Europe; and there are many, many thousands of shepherds who graze their flocks on the thin grass which is found here and there. Such as have camels feed them upon the thorn bushes as well.

Let us pay a visit to one of these little Bedouin villages. It stands near a stream, far out on the sandy plain, without a tree or a house or any other building in sight. The only living things about are the dark-skinned men, women, and children, and the animals belonging to them.

The tents are scattered over the sand and in their midst is a walled inclosure in which the sheep and goats are driven at night.

Now suppose we examine the tents. Did you ever see such curious dwellings? They are so low that one has to bend down on his hands and knees to go into them. They are made of coarse black cloth woven in stripes, spread over poles, and tied down by pegs in the sand. As we come nearer we stoop and look in. There is but little furniture. There are no chairs or tables and the only beds are rugs or cloths spread out upon the sand. Lying about are a few saddles, and some bags filled with clothing. This little home has a wall of cloth through the center, dividing it into two parts, of which one is intended for the women and children, and the other for the men and older boys. Others of the tents have but one room, where all live together.

See the little ones playing about outside. They are dark-skinned, made so by the sun, which is hot in this part of the world. They roll about in the sand. They pile up stones, forming inclosures like those their fathers have made for the flocks, and put white and black stones inside them, pretending they are sheep and goats.

Now look there away off at the right. See those boys who are aiding their father in watching the sheep feeding on that green patch in a hollow place near the stream. The boys wear long gowns of white and their heads are wrapped up in white cloths around which thick strands of brown rope are tied. The man has on a turban and his long white gown falls to his feet.

But see, they are coming this way. The sun is just set-

ting and they are driving the sheep and goats home for the night. They greet us in a friendly way, as they come up; and at their invitation we sit down and take dinner with them. The meal is spread on the sand just outside their little tent home. It consists of a kid which was killed in our honor, and of couscous made of flour, herbs, and flesh. The flour is of millet, ground by the girls between two stones, moved one over the other, thus crushing the grain. The kid is served whole, and our host tears it apart and cuts great slices for us. We all eat with our fingers, and at the close are given some dried dates for dessert. Our drink is water from a goatskin bag filled at the stream, and tea served with sugar and mint.



Indian tent.

As we travel on our camels over the desert we pass many tent villages, and frequently see Arabs driving their flocks to new feeding grounds. They are always on the march, although they may now and then stop for a time near some oasis to sell their sheep or wool, and see something of the life of the towns. They are soon on the

way again, however; and even while near the oases they dwell in their tents. Many of the Arab shepherd boys do not know where they will be living next month, and some have several different homes in the course of the year. Such is the life of the nomadic tent dwellers, of whom millions are living to-day. It was the same with the Indian boys who, with their parents, roamed the United States searching for new hunting grounds at the time our forefathers came, and it is still so with many of our Eskimo cousins who, with their dogs and their reindeer, move their skin tents from place to place during the summer on the lookout for game.



Skin tents form the summer homes of the Eskimos.

3. PEOPLE WHO LIVE IN HUTS

THE hut is the simplest form of man's permanent home. It has been used since the beginning of history, and is still to be found in one shape or another all over the globe. It is the chief house of the African, and about the only shelter used by the natives of the islands



Sod hut in Lapland.

of the South Seas. There are millions in China and India who dwell in huts, and we shall see such habitations scattered over the South American continent. Even in civilized Europe and in our own North America some of the poorest of the people have huts of one kind or another;

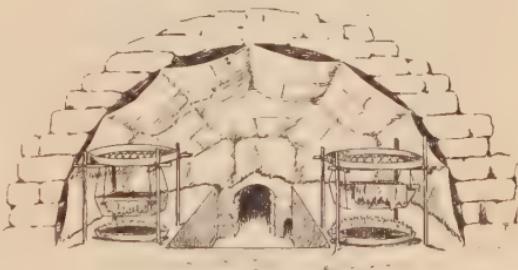
and indeed, such dwellings, made of straw, stone, brick, and wood are to be found all over the globe.

The character of the hut depends largely upon the building material at hand, as well as upon the climate and needs of those who are to live in it. In the cold lands of the far north, the Eskimos employ thick blocks of ice, which they build up in a dome shape. These icy houses have very small openings, as one of the chief objects of the hut is for warmth. Is it not strange to use ice to keep warm?

In the hot lands of the Equator, huts are often made of bamboo canes woven together, and thatched with palm leaves or grasses of various kinds. Sometimes they are mere shelters without walls; and at others are loosely put together that the air may blow through. The aim there is to keep cool.

Near Timbuktu, in the Desert of Sahara, far north of where we are now traveling, are beds of rock salt out of which the people take blocks to sell to the caravans, which carry them to the oases and countries to the southward, where salt is in demand. The miners make their houses of these blocks. There is no rain in that part of the desert, and the salt serves for both walls and roofs.

If we should go to the plains and lowlands of the world we might find millions of men, women, and children living in rude dwellings of mud and sun-dried bricks. Many such



Section showing interior of Eskimo house.

places have but few stones, and the mud is often plastered over a framework of poles, canes, or grasses in making the walls, while similar materials serve for the roofs or a thatch takes their places.



Eskimo village, eastern Alaska.

In the mountains and other rocky regions we shall find huts of stone or of earth mixed with stone; and where the vegetation is dense, some of grass and leaves, or perhaps of logs laid up like the cabins used by our forefathers.

Indeed, the huts are so many that it will be impossible for us to examine them all. They are usually the homes of the poor, and in the wilder parts of the earth are little more than shelters from the weather and places for sleeping at night. There are many such dwellings on this great continent of Africa, where we now are, and we shall visit some of them first.

The huts of the oases have walls of mud with a framework of date palm wood for their windows and doors. Such houses are small, seldom containing more than two or three rooms. The ground is the floor, and the flat roof is often of palm branches woven together and covered with mud. There is but little rain, and waterproof coverings are not needed. The houses are built in villages along narrow streets, without sidewalks.

In the larger oases the people have better homes; and, in Ghadames, a town in the heart of the desert, the houses are of two stories, the upper ones extending out over the streets, so that going through it is like traveling through



A street in an oasis village.

tunnels. There are stores on the ground floor, and the people live in the rooms overhead. The buildings are box shaped, with flat roofs, which often form the beds of the family.

Traveling on eastward we come to the homes of the Egyptians in the Valley of the Nile. The majority of these people are peasants, who dwell in huts of sun-dried brick. Their building materials are about the same as those used when the Israelites worked here for Pharaoh in the times of the Bible. The huts stand in villages on the banks of the river, or along the narrow roadways which run through the green fields on both sides of the Nile. They are often shaded by date palms. They look bare and dreary, and have few of the comforts of even the poorest of our American homes.

These Egyptian houses are so small that we can see over the roofs as we sit on our camels. They are seldom more than fifteen feet square, and have only one or two rooms. The roofs are flat. On many of them are stored the bundles of cornstalks and brush which the people use for fuel. Imagine having your woodpile or coal bin on the roof!

Egyptian huts have no chimneys. The cooking is done on a clay stove out of doors. The windows are high up, and are little more than holes in the walls. There is no furniture to speak of, and a ledge of earth at the side of the room serves as the bed and chairs of the family. In the towns the houses are better, and in the cities some are as large and as fine as our own homes.

Leaving the Nile Valley and traveling to the southward we pass through wild lands where the huts are of every



Egyptian huts.

description. On the high plateau of East Africa, not far from Mount Kilimanjaro, live the Masai, who have circular



Building a Kafir home of ant clay.

dwellings made of woven canes and elephant grass plastered over with mud; and near Lake Tchad is Kuka, a large city whose houses are walled with reeds covered with mud, and roofed with straw thatch.

In the far southern parts of the continent live the Kafirs, black people who have dome-roofed dwellings of mud, and in other sections are other mud huts of various kinds. Not a few of these mud villages are in localities where wood is abundant, and we wonder why the natives do not use logs. One reason is the white ant, which is found in great numbers all over Africa. This little insect will eat anything wooden. It works in the dark, and will burrow inside a rafter or post and eat away at it until only a shell is left, when the structure of which it is a part falls to the ground. These ants are home builders themselves. They

dwell in great mounds of many rooms which they construct by mixing the clay or earth with a juice or saliva from their mouths. This turns the clay to a cement which, as it dries, hardens like stone.

In making their huts the natives often use this cement-like earth which the white ants have prepared. They either drive out the ants, or take one of the abandoned ant hills, and, by pounding and mixing the clay with water, make a mortar, which they use to cover the framework of their huts, forming excellent walls. They spread this stuff over the ground for the floors, and thus have dwellings which the white ants will not destroy.

In many other parts of Africa the huts are made of grasses and canes of various kinds. The tribes about Lake Victoria have many such homes, each built after a



Erecting a home in Uganda.

style of its own. Some dwell in villages composed of houses surrounding corrals or fenced yards in which the cattle, sheep, and goats are kept at night; and others,



A hut on the shores of Lake Victoria.

such as the people of Uganda, have towns made of great and small huts of elephant grass, the stalks of which are about as thick as your finger. The Uganda dwellings are so beautifully woven that they look like basketwork. The roofs are of a thick thatch which shines like silver-gray velvet in the afternoon sun.

As to huts of stone, they are found in the mountainous parts of Africa, as well as in all other stony regions, scattered over the earth's surface. There are many in the Atlas Mountains, and in the Himalayas, the Alps, and the Caucasus. I have seen them high up in the Andes, where the Indians sometimes chink the holes between the stones with mud. The Indian homes are little better than ken-

nels, and not much greater in size. They have no chimneys, and their thatched roofs are often held down with stones on account of the high winds. Near them are the stone-walled inclosures where the llamas, alpacas, and sheep are kept at night.

Going down to the lowlands on either side of the Andes, we find hut dwellings with walls of reeds or of canes thatched with grass or palm leaves. There are many rude shelters along the Amazon and Parana rivers. There are



"There are many rude shelters along the Amazon."

huts of sun-dried brick in Chile and Peru, and in the city of Lima the chief buildings, including the cathedral, are formed almost entirely of mud. The South American des-

ert, which lies under the Andes on the west coast, is like the Sahara, in that it seldom has rain; and one heavy storm, such as is frequent in the Amazon Valley, would reduce the Peruvian capital city to the material our children use in making mud pies.

4. HOUSES OF GRASS, CANE, AND LEAVES

IT seems strange to think of American citizens spending their lives in shelters of grass, cane, and leaves. Uncle Sam has many such people, although they are not on this continent. They are, however, under the rule of the United States government, and we may rightly call them our little brown cousins. Take our relatives of Porto Rico, for instance. The poorer of them dwell in huts of cane or palm leaves. The Samoans, who live in the middle of the Pacific Ocean, have houses of grass. Until within a few years the natives of the Hawaiian Islands dwelt in grass shelters, and to-day there are many people in Guam whose homes are thatched huts. Farther off in the Philippines thousands of the poorer classes inhabit cane dwellings, the bamboo forming one of their chief building materials, and the broad leaves of the palm another.

But suppose we take ship and visit some of our relatives in these far-away lands. We shall start with Samoa. The first hut we enter looks like a haystack upon poles. Its thatched roof has been turned silver-gray by the weather. It reaches almost to the ground, extending beyond the gay-colored mats which form the walls of the dwelling. The mats rest against round posts which uphold the roof, and are so hung that they can be rolled up, allowing the air

to blow through. The floor is the ground, which has been covered with pebbles. There is a fire hole in the center,



A grass tent of the Andes.

the smoke from which has so colored the inside that the posts and roof shine like jet.

Upon the floor, mats of woven grass have been spread, and it is there that we sit or lie as we talk with our little

fellow citizens about themselves and their homes. They show us the furniture, consisting mainly of clay pots, bowls of coconut shell or gourds, wooden pillows, and mats of one kind or another. There are no stoves for heating, as the climate is warm, and the only fire used is

for cooking or to make a smoke to keep out the mosquitoes. There are no bathing arrangements, but the people wash themselves daily in the surf of the ocean or in the cold streams from the hills.

Traveling westward on our way to the Philippines we stop at the Fiji, Tonga, and other islands of the South Sea, as this part of the Pacific is called.



A home in the Fijis.

The dwellings here are much alike. They are of grass or cane, varying in size and character according to the tribes to which the islands belong. In one village the houses may be square, in another round, and in a third, perhaps, oblong like a hayrick. They are usually built upon a framework of palm trees, and most of them have little patches of taro or bananas near by. The walls may be of

thin wickerwork beautifully woven, or of reeds or grasses so sewn or tied together that they are three feet in thickness. The reeds are sometimes dyed before using, and many of the houses have walls of beautiful patterns. Nearly all have thatched roofs, and in some the roofs extend almost to the ground.

Most of the grass houses are exceedingly small, consisting of but one room. Those of the rich men and chiefs are large, ranging in length up to fifty feet and even more. Some of them have heavy ridge roofs which extend well out beyond their basketwork walls.

These island homes have but little furniture, although some are better supplied than those of our friends in Samoa. In the earthen floors of the Fiji houses there are raised places where the guests and other honored persons sleep upon mats or beds of sweet-smelling grass. The pillows are of wood, so cut that the neck just fits into them. The fire holes are large and pots and pans of burnt clay, wooden bowls, and other rude kitchen utensils are used.

In the large island of New Guinea, and in the Solomons near by, are savages whose homes are even stranger than those we have seen. Here are dwellings high up in the trees in order that the owners may be safe from their enemies, some of whom are head-hunters and supposed to be cannibals. The tree shelters are made of cane and palm leaves and are reached by ladders which are drawn up at night.

When we first took possession of the Philippines our soldiers found tree dwellers in southeastern Mindanao. Their thatched huts were made of bamboo and grass, and they entered them by climbing notched sticks which they

pulled up after dark. Those people were almost naked, the women wearing skirts about a foot long and the men little more than some cloth around the waist. The men had bows with which they shot poisoned arrows.



Moro hut upon bamboo poles.

Many of the Moros of the Sulu Islands dwell in bamboo huts built upon poles above the water, some distance out from the shore. Their houses can be reached only by canoes or the rude wooden bridges which in some cases connect them with the land. Similar houses are used by the Malays in the Dutch East Indies.

The buildings we have so far seen have each been the home of one family. In some of these far-away regions are dwellings made of grass and cane, so large that they

house many persons. Borneo has tribes which have huts several hundred feet long and sixty feet wide, one of which may contain fifty families. Such a hut consists of a framework of poles covered with a thatch of grass or of the leaves of palm trees. A hall runs through the center of the building, and this is faced by little stalls in each of which dwells a family. They cook in the stalls, and have their homes there, sleeping on the floor with no bed but some mats.

In the island of New Guinea are villages where the men dwell in clubhouses, while the women live in small huts off by themselves. The women do the cooking at the huts and bring the meals to their black lords in the clubhouses, within which they are not allowed to come.

But suppose we look further into the homes of our Philippine cousins. We shall not spend our time with those who live in the cities or towns, for the houses there are large, and in many respects not unlike our dwellings at home. What we would see are the huts and houses of cane, thatched with palm leaves, which serve as the homes of the poor. There are thousands of these scattered over the country in villages, or on the outskirts of the cities. Most of them are built upon posts so high up that they have to be entered by ladders or stairs. In parts of the tropics it is unhealthy to sleep near the ground; and besides, there are always reptiles and insects of various kinds which must be kept out.

The houses are usually built close together and those of the towns near the shore are shaded by coconut palms. We can see the great green and yellow fruit hanging in bunches high over the roofs, and now and then a nut

drops to the ground. There are banana patches near many of the huts, and here and there is a cluster of low trees, whose leaves grow to a length of ten feet or more, and up to two feet in width. That is the nipa palm, which furnishes much of the roofing of this part of the world. The leaves are cut off and sewed with fibers to a framework of bamboo poles in such a way that they overlap each other like shingles, shedding the rain. The framework is sometimes made on the ground, and the leaves sewed to the pole or rafters, before the roof is raised to its resting place on the wall. The walls consist of a framework covered with nipa leaves, sewed the same way.

In nearly every village we find clumps of bamboo, the great canes of which with their green feathery branches extend high over the houses. These canes form a building material which is the most valuable used by primitive people throughout the tropics. It serves as the rafters and often as the whole framework of the houses. It is of the same character as the cane fishing poles sold in our country, save that the larger bamboos are as big around as one's leg and as tall as a four or five story house. The bamboo is split and pressed out, making splints which can be woven like basketwork, and thus take the place of wide boards. Walls made of it are especially suited to the tropics, where the weather is warm all the year round, and the only requirement is to keep out the rain. The woven splints serve also for doors, and the holes made for windows have bamboo shutters which can be raised or slid back as desired. The whole canes are for the floors, being laid so loosely that the dust and dirt fall through the cracks and little sweeping is needed.

Moreover, by cutting out the knots and fitting the pieces together the bamboo canes form spouting and piping; and one section of a cane with a fiber handle attached makes a good bucket for water or milk. Much of the furniture of the tropics is made of this wood, and it has other uses of various kinds.

As we go on farther through the Philippine Islands, we find large houses made of bamboo, and also of board walls with roofs of thatch or tiles. In the larger dwellings the windows are sometimes of thin oyster shells set in a lattice-work, and those near the cities may have windows of glass. The furniture of such dwellings is simple to an extreme, consisting of a few chairs or tables and a bed of bamboo framework with a netting of ropes over which straw mats are stretched.

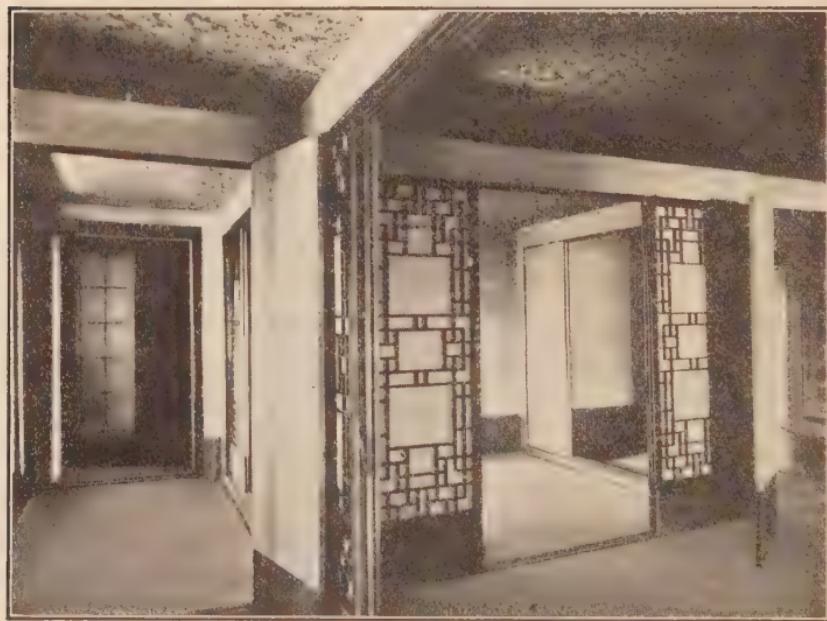


5. SOME ODD DWELLINGS OF FAR-AWAY LANDS

WE all know what our own homes are like and we shall learn more about them when we investigate the materials of which they are built. We shall do the same as to the homes of other peoples of the white race, all of whom have much the same civilization. There are other races, however, with other civilizations, whose homes are vitally different from ours, some of whom inhabit great countries and have much to do with the work of the world. This is especially true of the Japanese, Chinese, and East Indians who, taken together, number almost one half of mankind.

Suppose we make a trip to Japan. We are in a country

of many islands which have mountains covered with forests. The lowlands and the valleys are cultivated like gardens. There are villages at every few miles, while great cities are to be found here and there near the sea. The buildings are largely of wood with heavy roofs of black tiles or of thatch. They are of all sizes, from the one-story hut of two or three rooms, belonging to the poor farmer, to the great structures of two or more stories which cover a large area and have many apartments, the homes of the rich. There are also countless temples and many-storied pagodas.



"All the buildings are beautifully made."

All the buildings are beautifully made. The Japanese are skillful mechanics and their houses are as delicately constructed as a piece of fine furniture. The roof is first



The rooms are covered with straw mats.

built upon the ground, and then taken apart and set up in its place. The walls are of wood so fitted into grooves that they can be slid back and forth, turning several rooms into one. In many of the houses the outer walls are of boards made in sections so that they can be taken away during the daytime and the whole house be open. The best rooms face the garden, which is often at the back of the house.

Before entering the homes of our Japanese friends we take off our shoes and leave them outside. The floors are so polished that we can almost see ourselves in them. Most of them are carpeted with straw mats about an inch thick, a yard wide, and two yards in length; and the size of each room is known by the number of mats it takes to

cover it. These mats are so fine and white that no one would think of treading upon them in dirty boots. The Japanese always leave their shoes outside the houses and walk about in bare feet or in the mittenlike stockings they usually wear. They sleep on the floor, and at their meals sit there upon cushions before tables not quite a foot high. They have no heavy furniture, such as large tables and chairs, and therefore the thick mats last a long time.

The Japanese have many big buildings, and in the cities they are now erecting business structures like ours. They have magnificent temples covering acres, and the palaces of their emperor are of enormous size.

A night's ride on the ferryboat takes us across Korea Strait from Japan to the home of the Koreans, which is



"The Korean house is often of the shape of a horseshoe."

now a province of Japan. It is a land of big hats and long gowns, and its people dwell largely in houses of wood or in huts of stone and mud, roofed with straw thatch. The Korean house is often of the shape of a horseshoe, the women's quarters being put at the back. The better buildings are not unlike the Japanese. Their roofs are heavy and the interior walls are of wood latticework backed with white paper. Some of the Korean walls slide back and forth, and in other ways their dwellings are similar to those of Japan. They are not so well built, however, and those of the common people seem mean in comparison.

Leaving Korea and crossing the Yellow Sea, we find ourselves in the great world of China, comprising about one fourth of the whole human race. The Chinese are so ingenious that many of the great inventions, such as the compass, gunpowder, and printing, were discovered by them. Their history dates back for thousands of years, and in the centuries of the past they probably dwelt in better homes than those of our ancestors.

The Chinese homes of to-day are by no means so comfortable as ours, and they lack many of the things we consider necessities. Those of the very poor are squalid to an extreme. They are often mud huts made of sun-dried bricks, or of clay plastered over a framework of bamboo. The roofs are sometimes of thatch, but more often of clay or of tiles. The better houses and temples are of burnt brick of a bluish gray color with roofs of black or gray tiles. They are usually of but one story, although in some localities two and three story houses are built. They have heavy roofs of a ridge shape, the sides of which are



"The roofs extend out beyond the walls of the houses."

often curved. The roofs extend out beyond the walls of the houses.

Among the richer Chinese, each family has a number of dwellings inside a wall surrounding a large yard known as a compound. There are houses for the servants, houses for guests, and houses for relatives, in addition to those occupied by the family of the rich man himself. The buildings have windows of sliding latticework backed with white paper, much like the walls we saw in Japan. Such lattice-work is sometimes used for doors as well. Glass is not common in the ordinary home and most of the light comes in through windows of paper.

The Chinese have more furniture than the people of Japan. Beds, stools, and chairs are common, and there are wide wooden benches or lounges upon which they often sit or lie as they chat with each other.

The dwellings of the Chinese seldom stand alone. The farmers live in closely built villages, and in the towns and cities the streets are so narrow that it would be impossible for an automobile to pass through them. Hundreds of the cities are surrounded by brick walls and every large town has a wall of some kind. These walls are of vast extent. Those about Peking are twenty miles long and those which surround Nanking even longer. The Peking walls are so wide that two motor cars could easily pass upon them and they are as high as a four-story house. Such walls were originally made for defense and in some of the more progressive cities, such as Tientsin, they have been removed and the space where they stood is covered with buildings.

Crossing the Himalaya Mountains we come into India, a country which contains about three hundred million people, who, although they are dark skinned, have features like



Chinese pagoda.

ours. The most of them live in villages. It is estimated that there are more than five hundred thousand villages in the country. These villages are composed of mud huts with roofs of thatch or tiles. They have no comforts to speak of. The ordinary dwelling is often not more than fifteen feet square. It is so small that the family moves the beds outside during the daytime. The houses have no chimneys. The cooking is done on the ground or in rude stoves and the smoke gets out as it can. The chief fuel is manure and earth mixed together in the form of cakes which are plastered on the walls of the huts to dry.

Many of the Indian houses have separate quarters for women; and in the larger ones curtains are hung across the front doors to keep the men passing by from seeing the women within. Such homes have but little furniture. The people sit on the floor at their meals, and the ordinary bed is a network of ropes fastened to a rude frame of wood with legs less than one foot in height. Many sleep on the floor, or on the ground outside their huts.

The East Indians have also large dwellings with bathing arrangements, costly rugs, and other comforts. The rich live in great luxury, some of them owning palaces of several stories, with many rooms and beautiful gardens.

In such homes the women and girls have apartments of their own into which no men but those of the family are permitted to come. The same is true of most of the dwellings of India, Turkey, and Persia. According to their religion many of the people do not think it proper for a woman to be seen by any other men than her husband, and her brothers and sons. Therefore when a

stranger is about to enter a house he makes a noise to let the women know he is coming, and they then disappear. In Persia, for instance, no gentleman would enter the home of a friend without first stopping on the doorstep, and crying out, "Women away!"

We might continue our travels from India on into Burma, and crossing that country go to Siam. In Burma the natives live in houses of basketwork raised upon piles. The roofs are often a thatch of grass or palm leaves, and the dwellings are simple and easily built. In the low and oft-flooded lands of Siam there are many who dwell in houses afloat on the water. This is especially so at Bangkok, where thousands of men, women, and children have homes of one, two, or more rooms, anchored to piles driven down into the Menam River, which flows through that city. Each house has steps by which one can go down for a swim, and to which the marketing is brought in boats every morning. The children play about in canoes which they use with great skill. They are good swimmers, and they must be so, for their whole lives are spent within a few feet of the water.

In some of the rivers of China there are people who live upon boats. There are floating homes built upon rafts and in some of these the children play about with little wooden barrels fastened to their backs in order that they may be kept afloat should they fall off into the water.

But we shall find it impossible to visit all the homes of mankind. They vary everywhere with the civilization and the poverty or wealth of the people. They differ according to the building materials by which they are surrounded, and also as to the climate, the rains, the heat, and the cold.



In the Norwegian woods.

Nearly every country of Europe has houses unlike those of its neighbors. In the north lands, where forests are plentiful, the Norwegians and others have dwellings of wood, and it is the same in many parts of the Empire of

Russia. Farther south, where the trees have long since been cut away, most of the homes are of brick, stone, or clay. High up among the snows of the Alps are houses half stone and half wood, and there are some which have



A home in southeastern Europe.



How they live high up in the Alps.



stones on their roofs to hold them down against the winds of the mountains. In Spain many of the houses are of stucco, and those of the cities have iron bars over the windows behind which the little ones play.

There is no nation on earth, however, which has such homelike dwellings as ours, and we shall now return to the United States to see something of them and the materials from which they are built.



6. HOMES OF COLONIAL DAYS

OUR homes are far different from those of our forefathers. When the Puritans and Cavaliers crossed the Atlantic to settle in the New World, they had to cut their dwellings out of the woods. There were no sawmills and planing mills where shingles and boards, window sashes and doors, and all sorts of wood ready-made to be fitted into a house, could be bought. There were no hardware establishments with great stores of nails, screws, hinges, and locks of all kinds. There were no brickyards or stone quarries or places where one could buy lime, cement, and plaster. The whole country was a wilderness and the most of it covered with trees which had to be chopped down before it could be turned into farms.

Suppose you were one of a family just landed on the shore of a land of this kind with little more than an ax, a saw, and a hatchet or so; how would you begin to build you a home? You would first look about for some kind of shelter in which to stay while you could cut down the great trees and erect a log cabin.

That is what many of our great-great-grandparents did. They huddled together in caves when they could find them; or dug holes into the sides of the hills and made shelters there by driving in poles which they supported by crotched sticks sunken into the ground at right angles. Upon these, as a framework, branches and leaves and grass were fastened, making rude walls and a roof, which, added to the earth at the back and sides, formed their first homes.

In many parts of the colonies, and especially in the south, they built wigwams like those of the Indians, using mats, grass, or deerskins to cover the poles. Farther north they had wigwams and houses of bark. Within six years after the Pilgrims first landed on Plymouth Rock and began to erect their log huts, there were only thirty dwellings on the island of Manhattan, and all but one were of bark. These rude little shelters were situated on the lower part of the island. They stood on the very places which are now covered with steel and brick office buildings, some of which are thirty, forty, fifty, and even more stories high.

It was not long after the settlers came before they had their log houses under roof. Every man was his own carpenter, builder, and furniture maker. He chopped down the trees and hewed the logs into lumber. He then called upon his neighbors to aid him in putting the structure together and in raising the framework for the roof. In some places the walls were made of logs from fourteen to eighteen feet long set perpendicularly side by side in deep trenches, running around a square which formed the floor of the dwelling. The earth was then pounded down, and the logs fastened together with wooden pins and cross-pieces, after which the spaces between were chinked with

mud. Then a roof of hewn boards or bark shingles, or of a framework covered with thatch, was put on, and the main part of the house was complete.

In such cabins the logs were so cut as to leave openings for the windows and doors. The windows had wooden shutters with hinges of withes or leather, and sometimes



Log cabin.

a sash with panes of greased paper. The doors were of boards hewn from logs fastened to crosspieces, with wrought iron nails or wooden pins. They were hung upon hinges of vines or of leather. Sometimes bark doors and shutters were used.

The furniture consisted of a rude bed, a table, and some stools or chairs of rough wood, cut out of the trees. The huts made of fourteen-foot logs had but one story. Those of logs eighteen feet long had usually a loft in addition.

Many of the cabins of that time were of logs notched near the ends and laid horizontally one upon the others, crossing at right angles and forming an oblong or square room. Such logs were added, layer by layer, until the house was of the desired height, when the framework for the roof was raised into place. This was then covered with thatch, clapboards, or split shingles. Some of the logs were cut shorter to fit into the places where the openings for such windows and doors as have been already described were to be.

The house was then made tight, by chinking or filling in all the holes and spaces between the logs with mud and broken stones and by plastering the spaces with clay. The floor was the earth well pounded down; or, in the better cabins, it was of split or hewed logs called puncheons. A large fireplace was built in one end of the cabin, and this formed a part of the great chimney of earth and sticks, or of earth and stones laid up on the outside of the wall.

Such houses seem rude to us now, but they were the first permanent dwellings of thousands in colonial times. They were the homes of the earliest settlers, and as the pioneers chopped their way through the woods towards the Mississippi Valley each settler erected his log home, and, cutting down the forest about it, broke the land for his farm. Many such cabins are still to be found in the mountains and in the wilder woodlands of our country.

It was in houses like these that some of the most eminent men of our history were born, and to-day we have people living in palaces whose fathers or grandfathers were born in log cabins, and, as babies, were rocked in

sugar troughs. The sugar trough was a short section of a big log split in two, and so hollowed out that it could be used to catch the sap from the maple trees. In those days cans and buckets were scarce, and such troughs took their places. A trough was just about big enough to hold the baby, and it often formed the rocking and sleeping place instead of a cradle.

Captain Miles Standish lived in a log house, and the same is true of Captain John Smith and the other colonists who founded Jamestown. Not far from Berryville, Virginia, I was once shown a log hut in which George Washington dwelt when a boy of sixteen. He was then employed in surveying a great tract of land belonging to Lord Fairfax who paid him five dollars a day, and he used this hut as his home. It was not more than twelve feet square, and of about the same height, having a ridge roof covered with clapboards. The logs which formed the walls had been chopped square, and their ends so dovetailed into the corners that but few nails were needed. The cabin had two rooms, one above the other. It was entered by a door of hewed planks. There were no stairs, and the young surveyor who afterwards became the great General and President had to stand upon a stool or climb a ladder to reach his rude sleeping apartment.

Presidents Lincoln and Garfield were born in log cabins. When Abraham Lincoln was eight years old his father moved from Kentucky to Indiana. The family traveled on horseback, sleeping at night under the trees. When they reached the site of their future home, they put up a shed of logs and branches, inclosed on three sides, the fourth being open; and in this they lived for a

year. By that time Abraham's father had built a log house about eighteen feet square. The rude structure



Log cabin where Lincoln was born.

had but one room, and little Abe's sleeping place was made by fitting some slabs into the logs overhead, making a half loft which was reached by a ladder. The floor was the hard-beaten ground; and a bedstead, a table, and four stools,

all hewed out of trees, formed the only furniture. There was a wide fireplace, and, at the light of this, little Abraham Lincoln studied his lessons at night.

Garfield's log cabin home, built by his father, Abram Garfield, was in northern Ohio, near a tract of forest not far from Lake Erie. The nearest house was seven miles away. It was built of rough logs to which the bark and moss still clung. The roof was of pine slabs, and the walls were of logs so notched at the corners that they fitted quite close together, the spaces between them being filled up or chinked with clay. The house had a floor made of split logs hewn smooth with an ax; and its doors were of planks hung upon wrought iron hinges. The lock was a wooden bar which rose and fell in a wooden socket, as a leather string which ran through a hole in the door was pulled or let go. At night the string was drawn into the house and only those within could open the door.

This string was called the latchstring, and from this custom has come the expression denoting hospitality, "The latch-string is always out for you."

In colonial times many of the schoolhouses were made of logs, and in some the only desks were boards resting on pegs driven at the right height into the logs of the walls with benches before them. The teacher's seat was in the center of the room and the older scholars sat at these desks facing the walls with their backs to the teacher. The younger scholars sat on blocks or benches of logs between the desks and the teacher. Such schoolrooms were



Schoolhouse of colonial times.

frequently lighted by panes of white paper greased with lard, and fastened to sashes which fitted into the walls. The heat came from great fireplaces, the fuel being sent in by the parents as part pay for the teaching. It is said that

the child whose parent did not send his wood in on time was often forced to sit in the coldest part of the schoolroom.

As our country developed, the homes of the colonists began to improve. The cabins became larger. The logs were more smoothly hewed and there were many two-story dwellings. By and by buildings of clapboards or hewn slabs were constructed. Then sawmills were erected, and boards came into use. In Virginia, Pennsylvania, New York, and New England, the people soon began to build dwellings of stone. The first bricks were sent across the Atlantic Ocean from Europe. They were burned bricks of red and black, and were laid in a checkerboard fashion. The windows were made of tiny glass panes which were also imported. Many of these houses still stand.

As the people made more money their homes grew better and better, and among them were large and comfortable mansions, such as Arlington, owned by Martha



Mount Vernon, the home of Washington.

Custis, who married George Washington, and Mount Vernon, where they lived after marriage. The home of General Washington is preserved to-day, and it looks much as it did when he died. Arlington, which for a long time was the dwelling of General Robert E. Lee, now belongs to our government. It is a beautiful building, with many large rooms, and must have been a most comfortable home. The ground forms the site of Arlington Cemetery, which is situated on the hills facing the Potomac, opposite our National Capital.

At the time of our Revolutionary War, New York, Philadelphia, and Boston had what were then considered magnificent mansions, and soon after that many other fine houses were built. Great public buildings of stone, such as our National Capitol and the White House, were erected, and other large structures of many kinds were put up in various places. As the country increased in wealth and population, the business and official buildings grew better and better. This has been also the case with the dwellings of the poor and well-to-do, as well as with those of the rich; so that to-day it is safe to say that we have the most beautiful, the most substantial, and the most comfortable homes known to man.

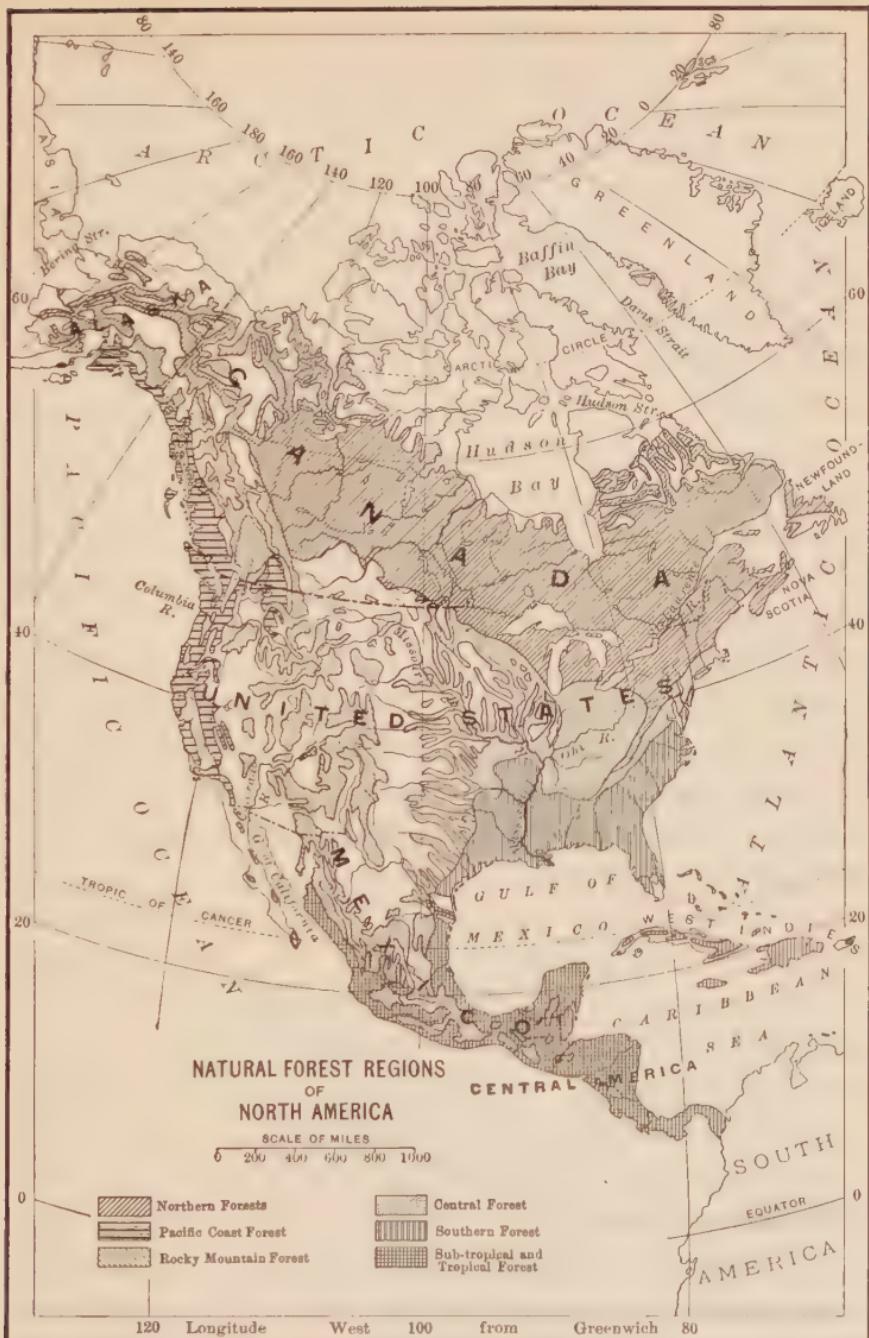


Arlington, the home of General Lee.

7. IN THE WORLD'S GREAT FORESTS

OUR travels to-day are to be in the forests. We all know that wood has a large part in making our homes and we wish to see some of the places from which it comes. When the earth was first peopled much of it was covered with trees. There were forests wherever the climate and rainfall were just right, and that was usually along or near great bodies of water. There were dense woods everywhere along the banks of the rivers, and upon the moist plains, and in the valleys and on the slopes of the mountains where the water-laden winds from the ocean blew against the cold air of the hills and dropped their burden of moisture. Almost the whole of Europe and a great part of North America had just these conditions, and they were therefore covered with woods. The same was true of many parts of Asia, and of much of northern Africa which is now bare of trees. But man needed shelter and fuel, and also cleared land on which to grow crops. He has continued cutting away the forests to supply these needs and for this reason vast areas of the original woods have long since disappeared.

Nevertheless, there is much woodland left. We find some along nearly all the great rivers, with the exception of the lower parts of the Nile and the Ganges. The forests of the Kongo in Africa are so dense that their shade turns the tropical noonday to twilight; and this is also the case in the vast basins of the Amazon and the Parana in South America. Much of our Mississippi Valley is still wooded, and the Columbia River flows through some of the most magnificent forests on earth.



If we could take an airship and make a rapid journey over the forest lands of the globe, we should find that most of them stand upon this northern hemisphere upon which we live, and that the most and best of the timber fitted for houses is scattered through the countries running around the northern part of this hemisphere. These countries are Russia, Norway and Sweden, Germany and France and Austria-Hungary in Europe, Siberia in Asia, and British America and the United States in our own grand division.

It is true that Africa, South America, and Australia have also large forests; but the woods of those countries are usually so heavy that they will not float, and the difficulty of getting them to the markets is such that they have but little part in the world's building materials. On the other hand, the woods of the northern hemisphere are of such a nature that the logs can be floated to the sawmills or to the places where the lumber is most in demand. Moreover, the climates are such that the snow can often be used in dragging the logs to the streams.

But let us suppose that we are soaring over Europe in our airship. We shall imagine that we have our field glasses glued to our eyes, and that they are so strong that we can take bird's-eye views of almost the whole continent. There are woodlands in all parts of it. Europe has, it is estimated, more than seven hundred and fifty million acres of timber, and this comprises about one third of its territory. The thickest woods are in Russia, in the northern part of which are vast forests that have never been touched by the ax. The same is true of Finland and of Sweden and Norway. Germany, France, and Austria-Hungary

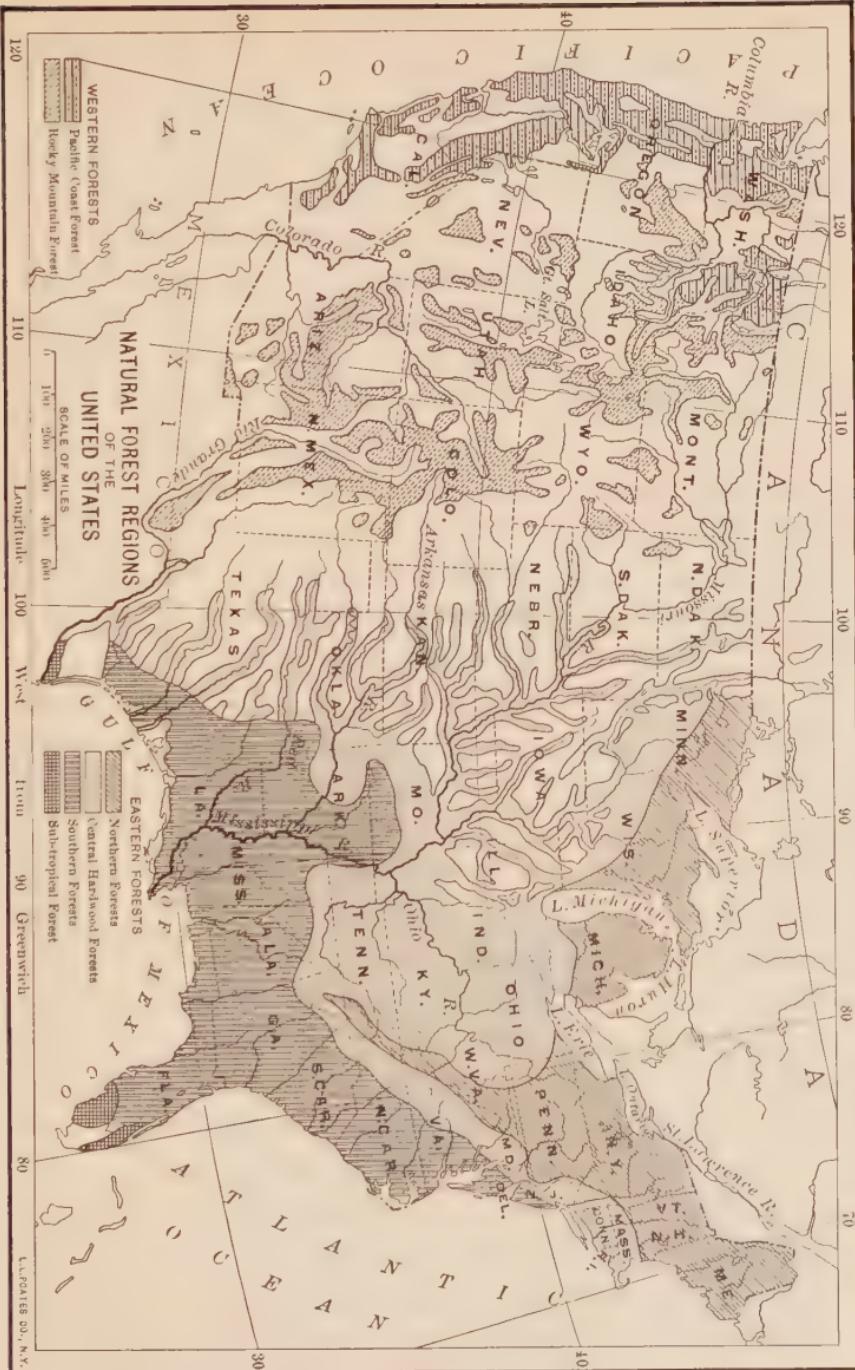
have also large tracts of valuable trees which have grown up within the past few generations, and their governments are always setting out more. There are tree nurseries in almost every country; for the people of the Old World have come to realize the value of forests, and they are taking good care of the woods they have left.

Every country has national forests of great extent, and the waste lands belonging to the state are being set out with new trees. The lumbering is so carried on that only the full grown or ripe trees are cut, and nothing is wasted. The same methods are used in the private forests, and as a result in some of these countries the supply of timber is increasing from year to year. It is different in the United States, where, although we have large areas of national forests, we are destroying our other woodlands in the most wasteful way. But we shall see more of this as we go over the country.

Now we have left Europe and crossed the Atlantic. We are taking a bird's-eye view of North America. Our continent still has more and better timber than any other part of the world. The forest area of Canada is greater than the woodlands of all Europe, and the timber left in the United States is even more valuable. The forests of Canada begin in Nova Scotia and New Brunswick on the Atlantic and stretch from there clear to the Pacific, a distance of more than three thousand miles. This long belt of woods is in places about two hundred miles wide; and fully one fourth of it contains timber that will make homes for men. North of our Great Lakes are vast regions covered with pines, and in British Columbia are to be found some of the finest trees of the world.

But of all the forest regions on earth the most interesting to us are those of the United States. Moreover, they are of all the world still the most valuable, although the greater part of the trees which once covered our country have been burned and otherwise destroyed in clearing the lands to make farms. At the time the Puritans came to New England and Captain John Smith and his colonists to Virginia, there was a vast stretch of woods which began at the Atlantic Ocean and extended westward to the Mississippi River, with the exception of a part of the plains of Illinois. West of the Mississippi this forest covered the most of Missouri, Arkansas, Louisiana, and a great part of Texas and Oklahoma; and in addition there were extensive woodlands in the Rocky Mountains and along the Pacific Ocean.

The forests of that time taken together covered almost one half of the land on the main body of the United States. Our government experts have estimated that they contained so much good wood for building that cut into lumber it would have equaled fifty-two hundred billion feet of boards one foot wide and one inch in thickness. This amount is beyond our comprehension. But if for easy figuring we take fifty-two hundred feet instead of fifty-two hundred and eighty feet as the length of one mile, and divide the fifty-two hundred billion by that, the result is one billion, showing that there was lumber enough to make a board walk, a foot wide, one billion miles long. Now the distance from the earth to the sun is ninety-three million miles and to the moon two hundred and forty thousand miles. If we could bridge air and space, our lumber would have been sufficient to cover a street ten feet wide reaching from the



earth to the sun. That would have taken nine hundred and thirty million miles of lumber and left something like seventy million miles to spare. The remainder would have paved a road more than two hundred and ninety-one feet wide all the way to the moon, and had we nailed it down, covering sea and land, around our little earth at the Equator, have made a board belt twenty thousand wide or of a width of three and a half feet with many millions of boards sawed into flooring, it would have been enough boards to have covered England with the addition of Jersey, Pennsylvania, Delaware, and Maryland.

Of these vast woodlands perhaps was the Northern Maine through New York and the most central and north-south in to Minnesota, Appalachian Mountains, Georgia. covered an state of

it would have sand feet half miles, to spare. If have furnished the whole of New New York, New ware, and Maryland.

the most valuable forest, which ran from England, across New York, through Pennsylvania, through Michigan and Wisconsin, extending along the Appalachian Mountains as far southward as Virginia. Roughly speaking, this forest area about six times that of the Virginia or Kentucky. In it there were many cone-bearing trees. It was the home of the white pine, which was mixed with red pine, spruce, hemlock, cedar, and fir, as well as birch, cherry, maple, and some other hard woods. The total amount of timber



BOARD WALK NINETY THREE MILLION MILES FROM THE EARTH TO THE SUN.



in that forest was perhaps one billion feet board measure, a board foot being one foot long, one foot wide, and one inch thick.

Another extensive wooded tract of the East was the Southern forest. This began in southern New Jersey and covered all our South Atlantic and Gulf states, as well as parts of Texas, Arkansas, and Oklahoma. It contained many pines, of which the yellow pine was the most numerous. It covered more than two hundred million acres, and had as much timber as the Northern forest.

Between these two was the Central forest, which extended from the Atlantic to the great western plain. It was composed chiefly of hard woods, and before the clearing began comprised about two hundred and eighty million acres and contained more than fourteen billion board feet of standing saw timbers. This timber was walnut, oak, elm, hickory, maple, chestnut, sycamore, red gum, and ash, as well as basswood, cottonwood, and some other trees.

The forests of the Rocky Mountains were situated on the higher plateaus and slopes. They were almost entirely pine and contained less than half the amount of timber that stood in either the northern or the southern portions. The original extent was not over one hundred and ten million acres.

The Pacific Coast forest was less in area than any of these others. It was thickly timbered and the trees were so tall that it surpassed in the amount of the good timber then standing any of the other forest regions, excepting the hard wood forest of the central belt. This forest extended through the greater part of California, and of

Washington and Oregon. It was composed almost altogether of trees bearing cones, consisting chiefly of Douglas fir and redwoods, many of which were two hundred or more feet in height and of enormous thickness. In addition to these there were vast quantities of fine yellow pines, red cedars, sugar pines, and other firs and spruces.

Such were the woods which we had in our country when it came into our hands. Of this vast treasure more than one half has already disappeared. By cutting, clearing, and forest fires the area of the woods has been so reduced that it does not now amount to much more than one fifth of the United States proper; and instead of our having fifty-two hundred billion feet of lumber still standing we have not half that amount. Much less than one third of the Northern forest remains. More than one half of the Southern forest has been cut away, and of the Central forest, we have not one fifth as much as we had when the country came into our hands.

The woods of the Rocky Mountain region are in a better condition. We have from one half to three fourths of them left, while in the Pacific Coast forests a much greater proportion of the trees are still standing, so that all together our forests are still exceedingly valuable.

Nevertheless, it is sad to think of the vast amount of good timber which has been wasted through fires and bad lumbering. Of late years the National Bureau of Forestry has done much to remedy these evils. Under its direction woodlands are being set out in most of the states, the national forests are being carefully preserved, and the trees are so cut that the ripe timber is turned into lumber, while the younger trees are left to grow for the future.

8. OUR LOGGING INDUSTRY

“This is the forest primeval. The murmuring pines and the hemlocks,
Bearded with moss, and in garments green, indistinct in the twilight,
Stand like Druids of eld, with voices sad and prophetic,
Stand like harpers hoar, with beards that rest on their bosoms.”

WE have crossed our wide continent, and are now on the western slope of the Cascade Mountains in the state of Washington, in one of the most densely wooded regions of the Pacific Northwest. Mighty fir trees, some as thick as the Pullman cars in which we crossed the Rockies, rise to a height of two or three hundred feet on all sides of us. Their green branches begin at one hundred or more feet from the ground, and they are so thick that they interlock and shut out the sun. The great trunks stand about like mighty columns, and we seem to be in a vast cathedral which reaches on and on as far as we can see, reminding us of one of Bryant’s Forest Hymns:—

“The groves were God’s first temples. Ere man learned
To hew the shaft, and lay the architrave,
And spread the roof above them,—ere he framed
The lofty vault, to gather and roll back
The sound of anthems; in the darkling wood,
Amidst the cool and silence, he knelt down
And offered to the Mightiest solemn thanks
And supplication.”

The sounds about us, however, are far different from those of a church. We are in the heart of a lumber camp, with hundreds of men sawing and chopping away on all sides. Not far from where we are standing is a stationary steam engine, which puffs and blows as it drags the mighty



"This is the forest primeval."

logs with steel ropes to the cars and with similar ropes loads them for shipment to the mills.

In order to see the better we have climbed upon a

great fir which has just fallen. It is two hundred feet long, and so thick that a cross section of it would reach from the floor to the ceiling of the largest schoolroom. Other fir trees are still standing, the tops of some of them piercing the sky three hundred feet over our heads. Except where the lumbermen have cut their way through, the



In the Oregon woods.

jungle is almost as dense as that of the Himalaya Mountains. The ground is covered with rotting underbrush. There are fallen trees and broken branches everywhere, and the older trunks have a thick coating of moss. There are giant ferns, and brambles with sharp thorns which tear one's hands and clothes as he makes his way through.

Not far from where we are the lumbermen are felling a

great Douglas fir. They have made cuts on the opposite sides of its trunk five feet from the ground and into these have fitted two springboards, upon each of which one of them stands. They are making a notch in the tree which will give it the right direction for falling. Their axes swing alternately, and each cut brings a great chip to the ground. By and by the gash in the trunk is so large that



Big tree of California with a company of soldiers on it.

a man could lie down inside it, and this gash determines the direction in which the tree will drop when the saw has cut its way through.

A little farther over we see another tree already notched, at which the lumbermen are cutting their way through the trunk. This is done by a cross-cut saw six feet in length, with a man at each end. The work begins at the

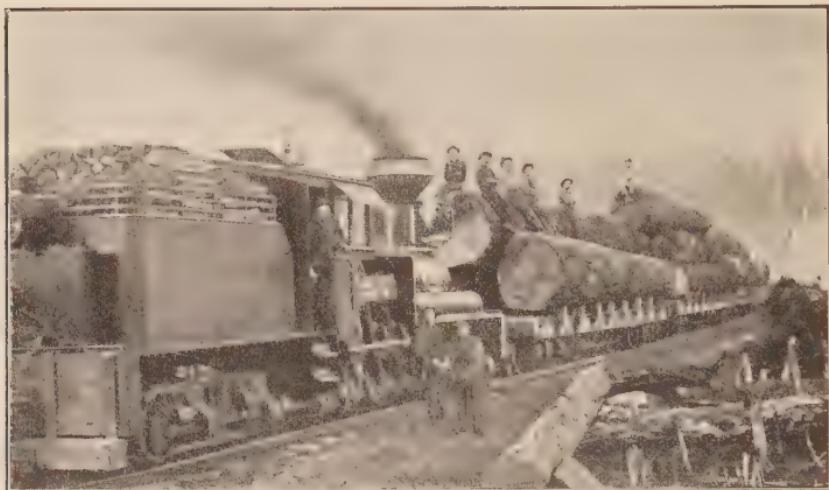
opposite side from the gash. The saw cuts like velvet as it eats its way through the soft bark. Now it strikes the wood, and the tree seems to shriek as the cruel teeth plow their way to its heart. That mighty giant has been hundreds of years in its growth. It came through the soil more than a century before Columbus discovered America, and it was one hundred feet high when our ancestors built their first log huts on this continent. Nevertheless, these men will cut it down in less than an hour, and within a few days it will be on its way over the world to make homes for man.

As soon as the tree comes to the ground other men take charge of it. They trim off the great branches and measure it, cutting gashes upon it twenty, thirty, and sometimes forty feet apart, at which places a third set of men saw it into logs.

Each log is now wrapped around with a steel rope, joined to the engine, and by this means is dragged over the ground to the railroad which has been built to take the logs out of the woods. Many of the logs are so heavy that they plow up the earth and sometimes tear up smaller trees by the roots on the way. A single forty foot log from one of the larger trees is a full load for one car, containing enough wood to make five thousand feet of good lumber. Some of the logs when green will weigh from twenty to forty tons, but the steel cable, moved by the engine, drags them through the woods to the track, each log looking like a huge live worm which sways its head this way and that as it goes.

As the log reaches the railroad, it is raised by another cable with heavy hooks on the ends. This passes through

a block suspended above the car. The hooks are fastened into the log, and as the engine is started it reels up the cable, dragging or raising the log to the car.



Trainload of logs.

In some of the lumber camps the steam engines move the logs to the streams, where they are rafted to the markets or to the railroads; and in other parts of the Northwest they are carried to the sawmills, from where the lumber sometimes floats down the mountain in great flumes or troughs of boards into which streams have been run. In California, in the heart of the Sierra Nevada, is a mill which has a flume sixty miles long. The lumber is thrown into this and it goes flying down to the trains and the market.

In many parts of the Cascades the logs are sawed not far from where they are cut and the lumber is carried on the railroads to the cities. In other regions the logs are floated down the Columbia, and from some places they go

into Puget Sound and are thence rafted to the great mills on its shores. Some rafts are so built that they can be towed by steamers from Puget Sound down to San Francisco and other ports; and on the Columbia River are similar rafts which are taken out into the Pacific Ocean and towed to the markets.

These giant rafts are often as large as the biggest ocean steamer. One constructed on the Columbia was seven hundred feet long, fifty-three feet wide, and thirty feet deep. It drew about twenty feet of water and contained all together seven thousand logs. This great mass was placed within a cradle much like the hull of an ocean steamship, and so wrapped around with chains that it was safely carried down through the Columbia, and along the coasts of Oregon and California, to the Golden Gate and



"These giant rafts are often as large as the biggest ocean steamer."

San Francisco Bay, a distance of more than seven hundred miles.

In our great forest regions east of the Rocky Mountains most of the lumbering is done in the winter, the logs being loaded on sledges, and carried on roads of ice or snow to the streams. The snow for the roads is often beaten hard and then sprinkled with water, which freezing, turns it to



Logs are carried on roads of snow to the streams.

ice. Some of the sledge loads are enormous, comprising forty or fifty logs sixteen feet long, containing many thousand feet of fine lumber. The sledges are drawn by teams of four, six, eight, and even more horses. When the loads reach the streams the logs are rolled out upon the ice, where they remain until spring. As the warm weather comes the ice melts, and the freshets carry the logs down to the rivers and lakes, where they are formed into rafts and floated or towed to the market.

The men who go with these rafts sometimes live in rude shanties which they build upon them. They are very expert, and run over the logs as they bob up and down and roll about in the water. They know just how to get the logs apart if they should pile up in one place, and how to keep them from jamming together as they are carried over the rapids or falls. When a jam occurs, one or two logs often form a key, which when pulled out releases the whole mass. The drivers, as they are called, understand where these keys are and drag them out with cant hooks. Such work is dangerous, and the men engaged in it are sometimes caught and crushed by the flying timbers, or dragged under the water and drowned.

In the southern forests the logs are taken to the streams by engines over the railroads or by wagons drawn by long teams of oxen or horses. They are put together in rafts, upon some of which the lumbermen and their families live as they float down to the seaports.

The trees of the Eastern forests are much smaller than those of the Pacific Coast, and most of the logs can, if necessary, be handled without the aid of machinery. Nevertheless the amount of timber cut is enormous. During the ten years from 1880 to 1890 it has been estimated that enough logs were floated to the markets from Minnesota, Michigan, and Wisconsin to have made a solid pile four times as wide as the average country road and as high as a four-story house, reaching across our continent from New York to San Francisco.

We enjoy the life of the lumber camp. The air is fresh, and flavored with the rich smell of the pines and the sawdust and chips of the newly cut logs. The lumbermen,

although rough in many ways, are full of good nature, and they make us at home. They show us their shoes, the soles of which are studded with sharp spikes which dig into the bark as they walk over the great logs and give them sure footing. We go with them to the camp and eat at the long pine table around which they gather at meals. Our plates are of tin and we have tin cups and bowls and tin spoons and steel forks. The food consists of soup, corned beef, potatoes, and canned goods of several varieties. We have excellent bread and cakes made by the camp cook, baked beans which remind us of Boston, and end our meal with mince pie hot from the stove. We are told that this diet is often varied with venison, squirrels, wild birds, and other game, shot in the woods.

We stay overnight with the loggers, sleeping on straw ticks in the wide bunks, built in tiers around the walls of the rude log house in which they live. Before going to bed one of our friends brings out a fiddle, and we laugh as we see these grown men dancing together. We turn in very early, for we are tired after our long day in the forest. By nine o'clock the lights are out. We fall asleep almost immediately, and do not wake until morning.

There are hundreds of such lumber camps in the Cascade Mountains, and a vast number very similar to them in California and in the Eastern forest regions of the United States.

All together we have several hundred thousand men engaged in the lumber industry, and the business is so extensive that its product often sells for more than a half billion dollars a year.

9. FROM LOG TO LUMBER

WE have left the woods and have come by train to Puget Sound to see the logs turned into lumber. We are about to visit one of the sawmills for which this region is noted. Its buildings cover more than fifty acres, and it has a water front big enough to load several

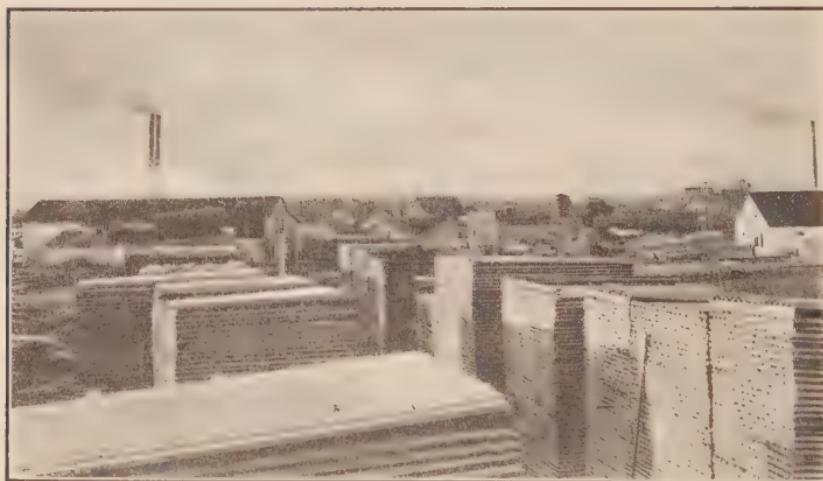


"At the docks are vessels taking on cargoes."

steamers at the same time. At the docks are huge vessels taking on cargoes of beams, rafters, flooring, and boards of all kinds, while upon the railroad, near by, the cars are loading for the lumber markets of the Mississippi Valley and other parts of the country. Some of the ships are bound for Alaska, China, Japan, and even South Africa. Others are taking on lumber for San Francisco and the Panama Canal. There is a sailing vessel just loaded starting out for Manila, and that tramp steamer

coming in will leave within a short time, carrying its cargo of boards to the Hawaiian Islands. Some of the Pacific Coast lumber is exported to Europe, South America, Australia, and indeed all over the world.

But come with me to the other end of the yard. We are looking down upon a bay or inlet with a narrow strait leading out to the Sound. The surface of the bay is covered with logs, floating about, awaiting the saws. Some of the logs are thirty or more feet in length, and many are as big around as a hogshead. Several men are moving about upon them, pushing them, one by one, to a great chute which extends from the water up to the mill.



In the lumber yard.

As the logs near the chute, they are caught by steel hooks on the ends of thick chains, and are dragged by the engines to the floor of the mill. They move as though they were alive, looking like gigantic snakes, as they crawl out of the water and on up the trough. There comes one



Sawmill in California.

now. It is five feet thick, forty feet long, and it weighs many tons. Nevertheless it flies aloft as though it were no more than a broom handle, and drops like a stick on the floor. Now great iron arms rise out of holes on each side of it. They catch it with their steel talons and roll it upon a truck which rests upon wheels on a track. One of the mill men pulls a lever, and the truck, moving forward, carries the log against a band saw, the teeth of which cut through it as though it were cheese.

See, a great slice has been pared from one side! It flies back, and another slice drops off from the side opposite. Now a steel arm with a talon at the end rises out of the floor and turns the log, so that the cut sides lie beneath and on top, while four other arms reach up and arrange it in place on the truck. The two remaining sides are sliced off in the same way, and our log has become a square

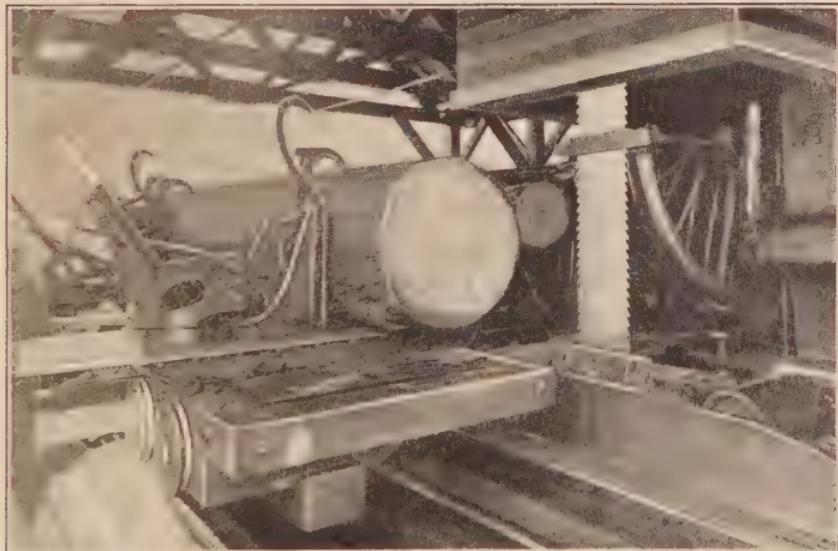
timber, each side of which measures four feet. A motion from the head sawyer and a pull at the levers, and the machinery cuts this timber into flooring. The boards pass on to other machines in which they are again cut, and finally come out in just the right widths. They are now carried on to the drying rooms, and later to the planers, where they are smoothed and tongued and grooved.

Other kinds of lumber are cut in the same way, the machinery doing so much of the work that the log is scarcely touched by man's hand from the time it leaves the water until in its finished state it is piled upon the steamers or cars for shipment to market.

We must keep our eyes open as we go through the mill. It is so noisy that, scream as we may, we cannot make our friends hear. The screeching of the saws is such that the men who do the work are directed by signs. They are all under the head sawyer, who might be called the brains of the machinery and who is paid very high wages. He stands under an electric light in about the center of the mill with his hands upon the levers which control the sawing. He motions the men at the trucks to touch such other levers as will so cut the logs as to produce the most and best lumber, and a few mistakes might cost his employers hundreds of dollars.

Now look at the saws. They are different from any used by our ancestors when they built the board houses of colonial times. Then and for a long time thereafter, most of the building materials were sawed out by hand. One method was by the pit saw operated by two men. The pit sawyer stood in a pit over which the log was placed and pulled the saw down, while the other, known as

the top sawyer, standing upon the log, drew it back in the opposite direction. The first circular saw was invented in England about 1777, but was not employed in America until many years later. Such saws are used now in the smaller mills of our country, but the great band saws



Interior of mill with a band saw.

and gang saws, such as we see here, are common only in the larger establishments.

The band saw is an endless strip or belt of steel, with teeth on one or both edges, so made that it can be fitted over two large wheels, one high above the floor and the other below it. The wheels are moved by engines, and as they go the steel belt flies around rapidly, its teeth cutting through everything that comes against them. One of the band saws of our mill is eighty feet long, and it rapidly cuts its way through the great logs as they are shoved against its sharp and fast-moving teeth.

The gang saw consists of a dozen or more circular saws parallel with each other, and so fastened to a spindle that they fly around at the same time. The saws can be so graduated that boards of any thickness desired are cut by them. The great log moves against them, and their teeth saw out a dozen or more boards at once.

Among the other machines used in our lumber mills are steam planers, which smooth the wood; lathes, which turn it into all sorts of shapes; and finishing machines for making moldings, panels, window-sash, doors, and woodwork of all kinds.

Every large lumber mill has its blacksmith shop where the breakages are repaired, and a department in which the men do nothing but file saws. There are also great kilns lined with steam pipes to dry the lumber, and special machines for carrying it out and loading it upon the steamers and cars.

The United States has many sawmills with machinery much like that in the one we have visited. It has hundreds in or near the Pacific Coast forest, and in our northern and southern forests. There are also many smaller mills scattered throughout the timber regions. Altogether we have more than eleven thousand lumber mills, which in some years cut twenty or thirty billion feet of lumber, board measure. We have hundreds of mills that make lath and other cheap lumber, and more than two thousand whose product is shingles. Indeed, a large part of our nation sleeps under shingles from the Pacific Coast forest, such roofing selling for millions of dollars a year. In the shingle mills the logs go in as bolts, and pass through machines provided with a series of knives which cut many shingles at once.

In our travels through the timber regions we may learn something of the kinds of wood most used in our houses, and the places from whence they come. The greater part of it is yellow pine, including therein all the pine lumber cut in the eastern half of the United States, excepting the white and Norway pine. This yellow pine comes chiefly from Louisiana, Arkansas, Mississippi, North Carolina, and Alabama, and in lesser quantities from Georgia, Florida, South Carolina, and Virginia.

After it we have the white pine, the annual product of which is often several billion feet. This is from the northern forests, and especially from the states about Lakes Superior, Michigan, and Huron. Next come the Douglas fir and Oregon pine, of which we saw something in our Washington lumber camp, and after them the hemlock, of which Pennsylvania cuts most, and then the spruce, cyprus, white oak, and other hard woods.

In addition to the wood used for building, a vast amount is needed for other purposes. Our railroads consume many millions of ties every year. We use an enormous quantity for furniture. We require millions of telegraph and telephone poles, and many acres of trees are cut down to make staves for barrels. The toothpick is little more than a splinter, but there is a single factory in Maine which makes a half billion of them every year; and we have other establishments which turn out lead pencils, clothespins, and wooden spools by the hundreds of millions. Several hundred acres of virgin forests are used annually for matches, and more than three thousand acres of hard wood trees are, it is estimated, cut up into shoe pegs.

There are also vast quantities of hard wood used for

carts, carriages, and cars of all kinds. A great deal of soft wood goes into buckets and baskets, to say nothing of the other soft wood trees which are annually cut down to be ground into wood pulp for the making of cardboard, and the paper which we use for wall coverings and for our newspapers and books.

10. WOODWORKING IN OTHER LANDS

OUR travels this morning begin in Burma. We are opposite our own homes on the other side of the globe. It is now evening in the United States, and our friends there are getting ready for bed. Here the sun is



In the teak forests of Burma where elephants draw the logs.

just rising in the eastern heavens, and day has begun. Perhaps some of us can tell why this is?

But our business here is to find out how woodworking is done, and to see whether it is really true that elephants help the Burmese build their houses. To do this we shall

first go to the great forests of teak which cover a large part of the peninsula of Farther India. The teak trees are tall, straight, and beautiful, and they make excellent lumber. They grow in tropical parts of the world and therefore there is no snow or ice on which to sledge the logs out. Much of the forest stands in the swamp and it would be difficult to lay railroads upon it or even to drive over it with carts. For these reasons elephants are used to drag the logs to the streams.

Teakwood is heavy, and the trees are girdled several years before they are cut. This causes the leaves to wither and the trees to die; the sap goes out of them and they become so light that they will float. They are now cut down with axes and saws, and chopped into logs. Then chains are wrapped around them, and one by one they are taken off to the streams. This is done by elephants, which are hitched by chains to the logs. After a time the paths become troughs, into which the water oozes and makes them so slippery that the logs slide along more easily. Now and then a log catches its end in the mud, whereupon the elephant stops and lifts it out with his tusks, and then moves it onward. The elephants push the logs apart when they pile up in the water; they also pull them out with their trunks and tusks, and lift them over the shoals. Only strong elephants are used for such work, the best logging animals being thirty, forty, or even more years of age.

We shall now suppose we have left the forests and have come to the lumber yards of the port of Rangoon near the mouth of the Irrawaddy River. Here many logs are sawed into lumber for use in house building, and also to

be exported to other parts of the world. Teak is one of the best of all woods for ships, and it is also valuable for making fine furniture. The yard we visit lies on the banks of the river. It has sawmills and planing mills, and we can see its great piles of timber before we come to it.



Entering, we find a score of elephants aiding the workmen; or we might better say that the



men are aiding the elephants, for it is the huge beasts which do the heaviest labor. They lift the great logs upon their tusks and carry them from one side of the yard to the other. They pile the lumber; and, when one of them cannot raise a timber to the place where it should be, he will often rest one end on the top of the pile and then lifting the other with tusks and trunk, give it a kick with his hind foot, which shoves it into its place. The elephants gather up the scraps of lumber and lay them so that the workmen can rope them into bundles. After this they

They lift great logs upon their tusks.

will thrust their tusks through the ropes and take the bundles as they are told. They drag the logs to the saw-mills and carry the boards to the steamers. Each of the great beasts has a man on his back, who directs him with a goad, at the end of which is a sharp hook. The elephant knows just what each touch of the goad means, and if he does not obey, the driver jabs him in the ear with the hook.

The elephants are intelligent. They know the hours during which their work is done. They grow restless as noonday approaches, and at twelve o'clock, when the whistle sounds, they will drop whatever they have on their tusks and bolt for the feeding sheds. It is the same when work stops at night.

We talk with the drivers and are told that the great beasts must be handled just so. Each has his bath twice a day, and, after this, is curried all over. The elephant is a sensitive creature. It cannot endure certain insects, and if the smallest bug creeps under its saddle, the huge beast will not work until it is removed. The largest elephant will tremble at the sight of a mouse, for fear, perhaps, that the little animal may run up its trunk.

We say good-by to the drivers on leaving, and throw them some coins. They rub the elephants' heads with their heels, whereupon the huge beasts raise their trunks high into the air and give us a royal salute.

These elephants are valuable animals. A full grown one will bring as much as a thousand dollars, and a prize worker several times that. They are caught in the forests of upper Burma. The wild ones are often captured in pits or corrals, being enticed there by tame elephants trained

for the purpose. When a wild herd is found, the tame beasts are let loose and allowed to mix with them. The latter follow the commands of their masters, and lead the herd into the corrals. The men then rush in and close the openings, after which the wild elephants are easily caught.

Traveling northward from Burma we cross over the mountains and spend some time in moving about through the great empire of China. This is one of the old lands of the world. The country has been thickly populated for ages, and the most of the forests have long since disappeared. There is no saw milling industry, such as is found in our country and Europe, and the methods of woodworking are crude. Boards are usually sawed out by hand, and the planing is done by the carpenters, who, block by block, work every bit into shape.



Making boards in China.

The sawing of lumber may be seen in all the Chinese cities, and we pass many log yards as we walk through the

streets. The logs are stood upon end instead of being laid flat as with us, and each is marked with a Chinese character which tells what it is. In turning a log into boards it is laid upon the ground with one end raised a little higher than the head of a man, and the sawing is done by two workmen with a cross-cut saw. One of the men stands above the log, and the other beneath it, and they pull alternately, thus sawing the logs. The work seems costly, but we learn that the wages here are so low that it is almost as cheap as though done by machinery. Such lumbering methods are employed here and there all over Asia. They are in use in many parts of Africa, and also in other places where civilization is backward, labor cheap, and machinery comparatively unknown.



Japanese carpenters at work.

The next stop in our travels is Japan, a country which now has sawmills and planing machinery, although much of its woodwork is still cut out by hand. We find the houses beautifully built. The Japanese are among the most skillful of all the world's workmen, and even the common carpenter is a cabinetmaker. We visit temples which are masses of carving, and observe that the walls of the buildings move back and forth as easily as the drawers of a bureau. We spend some time watching the carpenters,

observing that their methods of doing many things are just the opposite of ours. When a man planes he pulls the plane towards him, and in using the drawing knife he pushes it from him. We begin our houses on the ground, and work up to the roof. The Japanese makes the roof first. He then puts it together upon a scaffolding of poles, and fills in the framework beneath.

This method of roof-making is not confined to Japan. In Java the people often build the roof, which is of palm leaves and bamboo cane, on the ground, and then carry it to the framework of the house, where it is raised into place. In such cases the men bearing the roof walk inside it, so that the roof seems to be crawling along like a centipede, on numerous legs.

The bamboo is a favorite wood for buildings of many kinds in both Japan and China. It is cultivated for the purpose, and Japan has forests of well-kept bamboo trees which are cut and sold for timber. The Chinese use bamboo for more purposes than any other wood. It forms the scaffolding, inside which they build their houses. They tie the poles together, forming a framework more solid than though it were put up with bolts. They use bamboo for furniture, making chairs, tables, stools, and couches of it. It forms the carrying pole of the coolie, the ribs for the sails of the boatmen, and the rain hat of the farmer. It is the staff of the small-footed old woman, and the stick upon which the blind beggar leans. It is the measuring rod of the carpenter, and the handle of his tool. It is also largely employed in making toys for children, pen handles for scholars, cages for birds, and coops for chickens. The Chinese boy often sleeps on a bamboo bed, resting his

head on a bamboo pillow, which is a framework that fits under his neck. The Japanese use this wood for making paper, and it is also employed for medicine, while the young bamboo shoots are eaten for food.

Another wood of many uses is the palm. This does not grow to any extent in either Japan or China, but it is the



"The men bearing the roof walk inside it."

chief building wood of some tropical lands. It is of many varieties, and is employed in all sorts of ways. It is the principal timber of the Desert of Sahara, and the houses of the oases, which are composed largely of mud, have their doors and windows framed with the rough boards cut from the date palm. The coconut palm thrives in the warm islands of the Pacific, where it is used for

building. It is more valuable, however, for its nuts and the thick husks which surround them. The nuts are sold for making oil, and the fibers of the husks, loosened by soaking them in water, are twisted into yarn, from which is woven the coarse carpet or matting known as coir.

The leaves of the nipa palm take the place of shingles upon many of the houses of the Pacific Islands. They are sewed together with fiber, and tied to the bamboo rafters. They are also employed to cover the walls. The betel palm has a nut which is chewed by the natives of Siam, Malaysia, and the islands of the Dutch East Indies, much as some people chew tobacco. The carnauba palm has not only a fiber which the natives of Brazil use for hammocks and other purposes, but from its leaves oozes forth a wax which makes excellent candles. In some years millions of pounds of this wax are sold for house lighting.

II. AMONG THE RUINS OF SOME GREAT BUILDINGS OF THE PAST

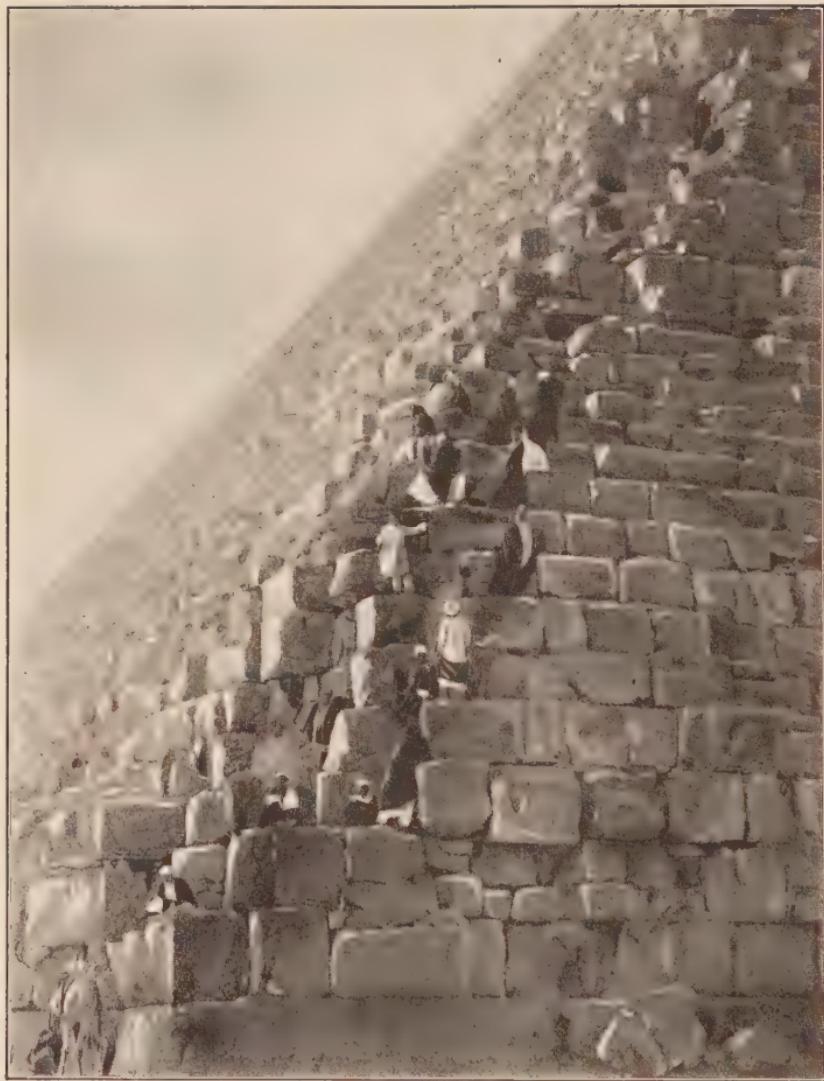
THE next field of our travels relates to stone as a building material, but before visiting the great quarries from which it comes, we would see something of how it was used in the past. It was ages after the half-naked savage built his hut of rough stones that mighty structures were erected of marble and granite. These were first made, not as homes for the living, but as tombs in honor of kings, or as temples for the worship of gods.

Some of the oldest of such monuments are in Egypt on

the banks of the Nile. Let us visit the Great Pyramid. We are standing on the sands of the desert about five miles from Cairo. The green Valley of the Nile running north and south lies between us and the city, but skirting it and extending back from it on all sides as far as we can see is a vast plain of gray sand and rock, out of which rises a mighty pile of stone so wide and high that as we stand close beside it it seems a wall to the sky. Its base covers thirteen acres, and it is laid up in terraces or steps of huge blocks of stone, some of which are as high as a table and many feet long. It has four sloping sides, which narrow as they rise and end at the top in a platform big enough to make the foundation for a good sized cottage.

We hire several black-skinned, white-gowned Bedouin boys as our guides, and climb up. The stones are so big that we have to be pulled and pushed from one terrace to another, and it is some time before we get to the top. The blocks are piled up in layers, fitted so closely that at first the whole seems one mass of stone.

In descending, we make our way around to a little hole on the thirteenth terrace in the northern side of the structure, and find there a narrow, slanting passageway, up which we crawl on our hands and knees to the two large chambers within. They are as dark as night, and bats fly past us as we enter. We have electric lamps in our pockets and by pressing a button get enough light to see well about us. The chambers are floored, walled, and ceiled with granite, polished as smooth as a mirror, and so closely laid that we cannot insert a knife blade in the cracks. These rooms were made about five thousand years ago to contain the bodies of King



A corner of the Great Pyramid of Cheops. "The blocks are piled up in layers."

Cheops and his wife. They lay there for ages, but from time to time the pyramid has been torn open by treasure hunters. The mummies and the things buried with them have long since disappeared, and now only a huge granite sarcophagus or coffin remains.

This pyramid was more than twenty years in construction, and it is recorded that one hundred thousand men worked upon it during a great part of that time. The Greek historian, Herodotus, relates that the onions, garlic, and radishes furnished the laborers cost almost two million dollars and that it took years to make the road over which the materials were carried. The stones of the pyramid numbered more than two millions, and of those that wall the king's chamber, single blocks weigh sixty tons. It is estimated that the structure contains so much stone that if it could be split into flags four inches thick, it would be enough to pave a road two feet wide over sea and land clear around the globe.

Traveling up the Valley of the Nile, we see other pyramids standing here and there in the desert, and after some days on our steamer reach Luxor, near the site of Thebes, an ancient city which had more than a million people. Thebes had walls so thick that chariots drawn by a half dozen horses could easily pass as they galloped around them. It had one hundred gates, and its temples and palaces were among the world's wonders. The homes of that day have long since passed away, but the ruins of some of the temples are still to be seen. We visit one at Karnak about two miles from Luxor, the huge stones of which, ranged about courts of enormous extent, cover many acres. In one court the roof was upheld by immense

columns of sandstone sixty feet high and from thirteen to fifteen feet thick, many of which are still standing. These



Temple of Karnak with obelisk in the rear.

columns are beautifully carved. They were erected, it is said, by King Menes more than forty centuries ago. The temple contained statues of gold and ivory studded with

jewels. It was for about two thousand years one of the most sacred places in Egypt.

Among the other things here are two obelisks, great shafts of stone like that which was brought from Egypt to New York and now stands in Central Park. The obelisks were quarried by ancient masons from hills of granite not far north of Luxor near Assouan, and some of them were carried down the Nile on rafts or boats to Alexandria, on the Mediterranean Sea. Others were set up at Thebes and some at Heliopolis, and at other cities along the great river.

Our own obelisk stood for centuries at Alexandria. When it was loaded for its long trip to New York a hole was cut in the bow of the steamer in order to admit it, and it was dragged through that hole into the ship. Some years before that another of the obelisks had been taken to London, being transported there in an iron water-tight cylinder which was carried to Egypt in pieces and built around the huge stone as it lay on the shore. After being encased, the great cylinder was rolled into the sea and a steamship towed it to London.

Is it not wonderful that these men who lived four thousand years ago could make such beautiful things out of stone, and could carry such heavy masses far down the Nile? It seems still more wonderful when we remember that they did this ages before man discovered how to use steam or electricity, and many centuries before he had invented machinery to aid in his building.

Returning southward to Alexandria, a few days by steamer takes us across the Mediterranean Sea to Athens, where, on a great hill of rose-colored limestone, stood



The Parthenon.

the Parthenon, one of the most beautiful marble temples ever erected. We drive to the foot of the Acropolis, as this hill is called, and wind our way to the top. We are now five hundred feet above Athens, with magnificent views of the mountains and the blue Mediterranean and its numerous islands. All about us lie huge broken columns and other pieces of marble beautifully carved. The ruins of temples stand here and there, and upon a marble platform, covering almost half an acre, are some of the columns which once upheld the temple in which stood the gold and ivory statue of Athena, the Goddess of Wisdom. This temple was the Parthenon. It was made of white marble, from the quarries of Mount Pentelikon not far away. The marble blocks were laid up without mortar, the columns being of cylindrical sections roughly hewed and finished after they had been placed in position. The front of the Parthenon was covered with

carvings, many of which have been broken off and carried to the British Museum at London. Some still stand, and some are now in the Museum at Athens.

We shall find other great works of marble built by the Romans in Italy, and also in northern Africa and Asia Minor, where they had colonies before the Christian era. In Rome itself they had magnificent structures formed of the marble which came from the mines of Carrara not far away. These buildings consisted of palaces, temples, and open-air theaters. The chief of the last-named was the Colosseum, a massive circus of stone and brick, inside which lions, elephants, and tigers fought together before the eyes of the people. They fought also with the gladiators, and the latter fought each other. In this place were held real sea fights, made by flooding the arena, and chariot races, and many other entertainments. The Colosseum had seats for more than eighty thousand spectators. It covered seven acres, comprising an arena or show place level with the ground and a series of galleries running around it extending upward in terraces until it reached



A column of the Parthenon.

the top of the walls at the back. The walls were one hundred and sixty feet in height, and when the sun was hot, an enormous canvas was stretched over them as a roof. The building contained many rooms, including cages for lions, tigers, and elephants.



A bit of marble carving from the Temple of Baalbek.

Traveling from Rome to Naples by train we take ship there and steam to Beirut in Syria, from whence a few hours' ride upon the railroad carries us over the first range of the Lebanon mountains to the famed ruins of Baalbek. These are the remains of a mighty temple of marble erected by the Romans to the worship of the heathen god Baal. The temple was built when the Roman Empire was in the height of its glory, and it was beyond description magnificent. Inside it was a solid gold statue of the god, representing a young man clad in armor and accompanied

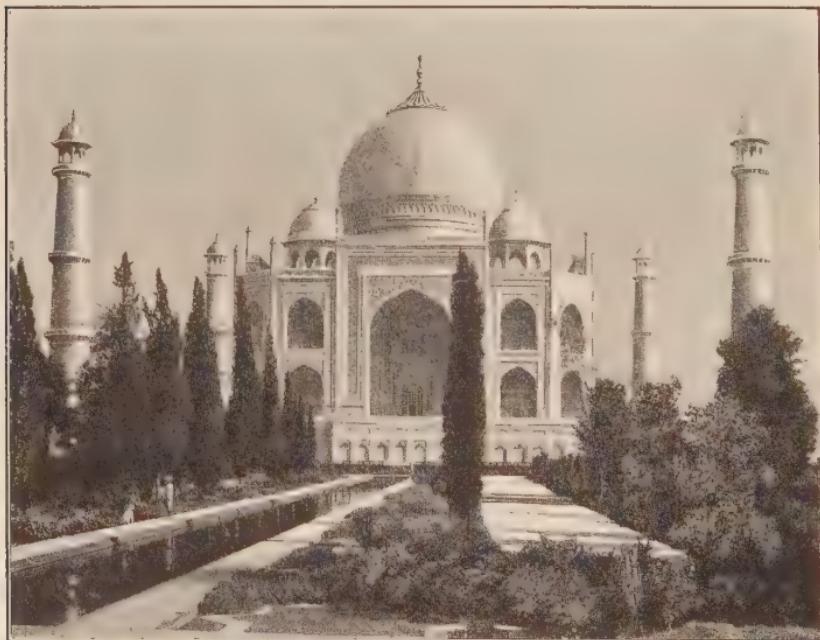
by two golden bulls. He held a whip in his right hand, and a thunderbolt and some ears of corn in his left. The temple had also statues of many others of the gods of the Romans, including Mercury and Venus.

The stones of this temple are gigantic. Some of the marble columns are as big around as a hogshead, and fifty or sixty feet long. They are put together in sections, and their capitals are exquisitely carved. In the foundation are great blocks of stone thirty-five feet long, twelve feet wide, and thirteen feet thick. Some of them are estimated to weigh more than fifteen hundred tons each; but notwithstanding their great size and weight they were carried over the hills from the quarries and placed in the walls without breaking. Such feats of engineering would be considered wonderful by our builders to-day.

As we look at the structure our guides ask us to visit the quarries, and see a stone which was cut out for the temple but which for some reason was left where it lay. We go with them and take measurements of it. The great block lies on the ground just outside the quarry with one end half buried in the earth. We climb up and take a run up and down it. It is just fourteen feet thick, and so wide that two automobiles could be driven abreast upon its face without falling over the sides. The length is seventy feet and if it were stood upon end, it would be as high as a six- or seven-story house. This huge mass is one solid stone, which was cut out for the temple. It is just like others which were carried there from this quarry and lifted to place.

Traveling on around the world we stop now and then

to see other famous structures built by the people of centuries past. At Agra on the banks of the Jumna River, in the heart of India, we visit the Taj Mahal, which is perhaps the most beautiful marble building ever erected. Travelers have called it a poem in stone; and one has said that it would be as easy to tell how the birds sing or the lilacs smell as to describe it. It is an ivory white mosque or tomb, covering acres, rising to a height one third as great as that of the Washington Monument, and ending in a dome which seems to float in the sky. The Taj Mahal is of the purest white marble, and the dome looks like a silvery bubble which might have been blown from the mouth of the heathen god Atlas, who, the ancient Greeks imagined, held up the skies on his shoulders.



"The Taj Mahal is of the purest white marble."

The Taj was inlaid with jewels, and in it are screens of marble latticework in patterns as exquisite as beautiful lace. It was built by a Mohammedan sultan, who was born just one hundred years after Columbus discovered America, and it was erected by him in memory of his wife. Near it stand other temples and palaces, including a building of marble so beautiful that those who made it engraved in Arabic letters upon its walls: "If there is a Paradise on earth, it is this! It is this! It is this!"

In the interior of the island of Java, we find a stone monument or temple which was erected to Buddha so long ago that the natives cannot tell when. It covers an area more than one half as large as that of the Pyramid of Cheops, rising in terraces decorated with statues and wonderful carvings in great profusion. I once counted eight carved figures on the stone walls in a space a yard square; and it is estimated that all the carvings if stretched out in one line would extend three miles. The statues about the monument number hundreds, and some of them are giants in stone.

Going northward to Peking in China we visit the Temple of Heaven, another mighty structure of marble. It consists of a great platform upon which the Emperor kneels when he sacrifices and prays for his people. In our own hemisphere in the wilds of Yucatan are the ruins of stone cities built by the Indians with their stone tools long, long ago. Moreover, scattered throughout Europe are magnificent cathedrals of stone built during the Middle Ages, and here and there are the ruins of stone castles in which the kings, knights, and barons of those days held their



We visit the Temple of Heaven.

courts. Indeed, the massive stone structures of the past are so many that it is impossible to visit them all.



12. A VISIT TO THE QUARRIES—MARBLE, GRANITE, AND SLATE

“ Little I ask ; my wants are few ;
I only wish a hut of stone
(A very plain brown stone will do)
That I may call my own ;
And close at hand is such a one
In yonder street that fronts the sun.”

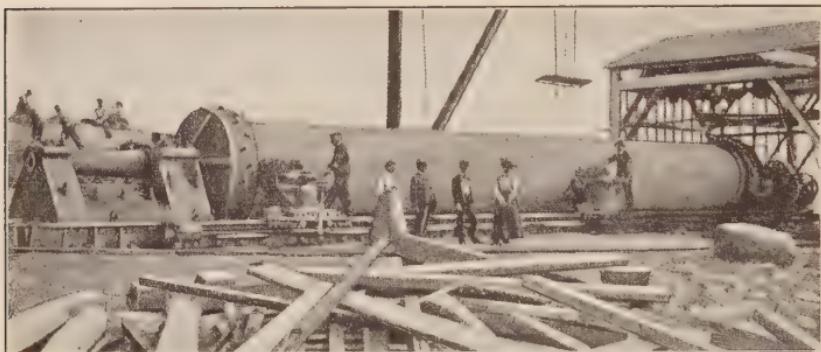
TO-DAY we shall learn something more of stone as a building material. We have seen how it was employed for the temples, cathedrals, palaces, and other costly

structures of the past. It is so used to-day. Our finest public buildings are made of granite or marble; and the brown stone mansion which Oliver Wendell Holmes jokingly refers to in the verse which begins this chapter is often spoken of as the home of the rich. We have, however, such a wealth of building stone in our country that it forms a large part of the dwellings of the people who are not wealthy; and by machinery the cost of fitting it for buildings has been so reduced that the stone house is within the purse of many men. Moreover, stone is used in all sorts of dwellings in combination with wood, brick, concrete, or steel; and we have few cottages so poor that they are not built upon stone foundations.

Indeed, the demand for building stone is such that getting it out and preparing it for the market has become one of our chief industries. We have vast sums of money invested in quarries, and their annual product sells for more than fifty million dollars. Thousands of men are kept busy taking out the stone and in cutting and preparing it for use. Other thousands are engaged in transporting it to the markets, and still others in laying it up in the various forms needed for building.

Before visiting the quarries, we should know something of the various kinds of stone most used. We have seen some of these in our travels among the ruins of the past. We found granite in the great temples at Thebes, marble in the Parthenon at Athens, and sandstone in some of the cathedrals and castles of medieval Europe. The best building stones are those which are strongest, most durable, and most easily worked. Of all, granite is perhaps the nearest perfection, although it crumbles under intense

heat. It has been used for ages, and is found to last the longest of all. It is very hard and it contains minerals of several kinds.



Cutting columns of Maine granite.

Our chief granite beds are in Maine and Massachusetts, although we have extensive deposits in many other parts of the Union. Granite is quarried in every state bordering on the Appalachian Range, and also in California, Colorado, Wyoming, Wisconsin, and Missouri. The New England granite is chiefly gray in color, although there are red and pink granites, and, indeed, some of nearly all colors from light gray to black. Fine red granite is quarried in Nova Scotia, Scotland, and Sweden. The red granite of Assouan near Thebes is close grained, and it takes a beautiful polish.

We all know what sandstone is, although perhaps not many of us could tell every kind of stone which goes by that name. All sandstones are composed of rounded or angular grains of sand cemented together by other materials so as to form a solid rock. The cementing materials are certain forms of iron, lime, and silica, and the color of the stone

varies much according to the cementing mixture and also as to the size of the grains of which it is composed. Some sandstones are gray, others blue, yellow, brown, drab, pink, or red. The red and brown sandstones of New Jersey are much used in the finer homes of New York, while many of our larger public buildings are made of the Berea sandstone from northern Ohio, which is almost white. Nearly every locality has its own sandstones, and we have many cities which are largely built of them.

Another building stone which we all know well is slate. We have all used slates and slate pencils, and many of us sleep under slate roofs and have slate mantels in our own homes. This stone is composed of a clay which has so hardened throughout the ages that it lies in a series of thin planes one above the other, and can be split off in great sheets. We have extensive slate quarries in Maine, Ver-



In an Ohio sandstone quarry.

mont, New York, Pennsylvania, Maryland, and Georgia, as well as in other states.

In mining slate the stone is cut by machinery and taken out in blocks. It is then split into sheets of the thickness desired. The roofing slates are cut from thin sheets, and laid on like shingles. The slate used for table tops and mantels is often two or more inches in thickness. School slates are thin sheets ground and cut by steel saws, ten inches in diameter, which go round at the rate of two thousand revolutions a minute. After this the slates are smoothed by machinery or hand, and then dyed. The dye soaks into the slate, and makes its color uniform.

Next to granite, limestone is the most durable of all building stones, and it is about the most used. It consists of carbonate of lime with various impurities which give it its color; so that it is found in all shades and tints from white to blue, green, yellow, pink, red, and black. It is of many varieties, from the coarse stones used for paving to the pure white marble from which statues are cut, or the alabaster or onyx of our clocks, vases, table tops, and mantels. Limestone is also burned to make lime. It is used in the smelting of iron and lead and in glass manufacture, so that you see in one form or another it has a great deal to do with our homes.

Among the most beautiful of the limestones are the marbles. These are fine crystals so combined that in its purest form the white stone will sparkle and flash in the rays of the sun. Marbles are of different colors, made so by the other substances mixed with the lime. We find them pink, red, yellow, or brown, and often drab, green, and black. The same stone may have numerous colors running in veins

and otherwise through it, and we have some localities where there are beautiful marbles of many hues. This is especially true of those from Tennessee and Georgia, while those of Vermont range from snow-white to green or dark blue.

Some of the finest and purest marble ever discovered came from the Greek island of Paros. It was from that stone that the ancient Greeks made their most beautiful statues. The marble of the Parthenon came from Mount Pentelikon not far from Athens, and a large part of that employed in the Forum and the palaces at Rome was from the quarries of Carrara, which have been mined for thousands of years. The emperor Cæsar Augustus said it was due to them that he was able to transform Imperial Rome from a city of brick to a city of marble.

The Carrara marble mines lie on the slopes of the Apennine Mountains. They are close to the town of Carrara, and five miles from the little port of Avenza on the Mediterranean Sea. They are situated near the railroad between Pisa and Florence, and can be easily reached. Comfortable steamers leave New York every week for Gibraltar, Genoa, and Naples, and from the two latter ports we can easily get to Carrara by rail, or by a small coasting steamer can land at Avenza. We shall do the latter. As we step out upon the wharf, we see many boats taking on marble, and long teams of horned oxen, bringing great loads of the white stone down to the ships. The marble is in blocks of all weights from forty tons downward, and it glistens in the sunlight as it lies on the quays.

We wind our way in and out among such blocks as we

go to the station, and our journey to Carrara is through a country of marble. The railroad track is ballasted with it, and the train now and then passes through tunnels cut out of the white rock. On all the sidings are trucks loaded with marble and the very streets of Carrara are snow-white .

from the marble ground into them, while marble dust fills the air.

The town of Carrara has thirty thousand inhabitants. At first sight it seems to be one vast marble workshop. In every street we hear the chiseling, sawing, and grinding as the tools cut the white stone. In this shop they are making mantels for fireplaces, in that they are carving out



Quarrying at Carrara.

tombstones and statues, and on the other side of the way is a building where the sculptors are making the decorations for a palace in France.

We put on dark glasses to shield our eyes from the glare all around us, and go out to the hills where the men are blasting the rock. The country is all solid marble. The quarries extend far up the mountains and there are



"There are large marble quarries near Rutland where the stone is got out by machinery."

workings all the way up. The men begin at the foot of a hill and blast down the rock, cutting out great amphitheaters. There are several hundred quarries now working, and in them about seven thousand men are busy year in and year out. The annual product is often two hundred thousand tons, and this is carried to all parts of the civilized world where the finest and purest of stone is required.

The men work carefully. They understand just what holes to drill, and where to insert the dynamite to break off the marble in pieces of the right shape. They know how to lower the blocks, using ropes as big around as our ankles in moving the stones down the mountains on sleds of beech wood. When they get to the bottom the marble is raised by jackscrews to the wagons or trucks, and carried away by engines or oxen to Carrara or Avenza.

But suppose we return to the United States and see our own quarries. We use something like twenty-five million dollars worth of marble a year, and almost the whole of it is produced in different parts of our country. More than half comes from Vermont. There are large marble quarries near Rutland where the stone is got out by machinery, and handled much better than in the mines of Carrara. The chief quarries there are under what was once a hilly sheep pasture and a swamp which adjoined it. The land was formerly worth so little that it was refused as security for a few hundred dollars; and in 1836, when William Barnes offered an old horse valued at seventy-five dollars for it, the owner was glad to sell. Barnes had noticed the marble rock jutting out of the earth, and he bought the place with the idea of burning it to make lime. He started his kiln; but soon after began to manufacture tombstones of marble,

and thus unearthed this treasure vault of beautiful stone. In time Rutland became a great marble quarry, and the stone mined there and in other parts of Vermont now annually sells for several millions of dollars.

In the quarries of Proctor, drills have been sunk to a depth of two hundred feet through this solid white lime-



Vermont marble quarry.

stone, and tens of thousands of tons of marble are annually mined. The water power of Otter Creek is used to generate the electricity which runs the machinery for sawing and cutting the stone and for turning and smoothing it for the market. The blocks are moved about by electric cranes, and by the same power are sawed into slabs of the shapes and sizes required. The cranes lift the marble as though it were feathers, a thirty-ton block being carried hither and

thither by the turning of a lever in the hands of a workman.

It is interesting to see how the sawing and cutting are done. A machine called a channeler is used. This consists of a row of long chisels so set in a framework that they move up and down as they go over the face of the marble ledge, cutting deep into the rock. After that cross channels are cut. Then wedges are carefully driven into these cuts, and the block splits apart without otherwise breaking.

In preparing the stone for the market it is cut into slabs and

other shapes by sand saws, which are blades of soft iron without teeth, upon which a stream of water mixed with sand is poured. The sand does the cutting, grinding out the stone as it rolls over it, pressed down by the saw. This method of cutting marble was known to the ancients, but its use in our American quarries came from the invention of Isaac Markham, a boy of ten years, who saw the marble workers grinding or smoothing



"A machine called a channeler is used."

their slabs with water and sand, which they rubbed over them with flat stones held in the hand. Young Markham made a model of narrow strips of steel so fixed in a

frame that it could be moved back and forth by a crank. This was first used in the quarries of Vermont, and from it came the machine sand saws, moved by steam engines.

In many of our quarries the stones are forced out of the beds where they lie by plugs and feathers. Is it not strange to think of feathers being used to split apart these hard stones?

Yes, but not so much so when you understand just what the quarryman calls "feathers." By this he means wedges which are flat on one side and half round on the other, the plug being another wedge with plane faces. In splitting the stone, round holes are drilled along the line where the breaking place is desired, and in each of these holes are placed a plug and two feathers. The round sides of the feathers with the sharp end of the plug or wedge between them just fit the holes, and as the plug is driven down it forces the feathers apart, exerting an intense pressure. At the same time the other holes are similarly treated, the combined force being so great that the hard rock breaks away.



Marble staircase of Congressional Library.

Some of our largest buildings have walls of marble and some have marble staircases and halls where the stones are beautifully carved. This is especially so in the Congressional Library at Washington, one of the most beautiful structures of modern times.

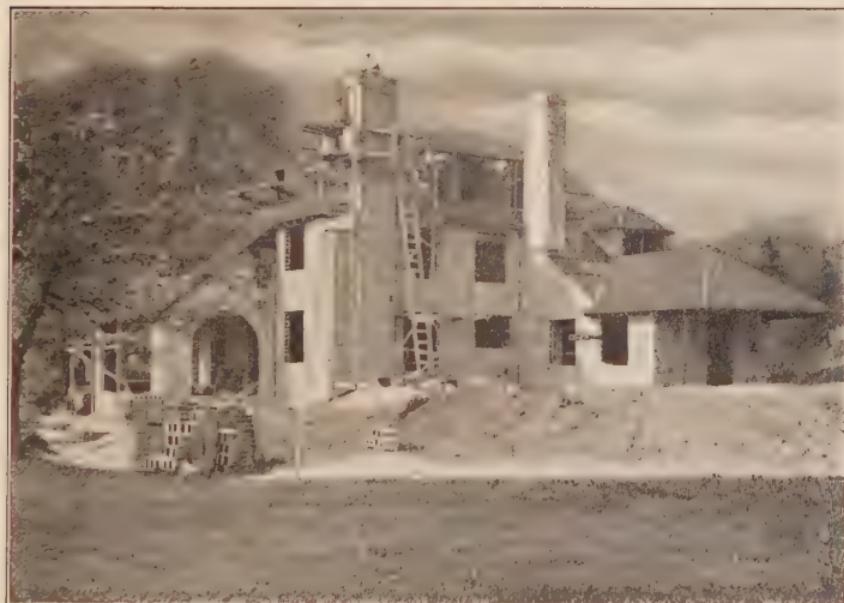
13. ARTIFICIAL STONE—CONCRETE, CEMENT, AND PLASTER

THE building stones we have so far seen are those made by nature, working throughout the ages. Some of them, such as the sandstones, are composed of grains of sand similar to that of the seashore, glued or cemented together by other materials and by pressure transformed into rock. The marbles are of white crystals often colored by the cementing materials, the sandstones receiving their colors in the same way.

All such stones formed by nature have to be cut into the shapes and sizes desired for building, and there are many places in our houses in which it is difficult to use them. For this reason man early began to look about for something which would take the place of stone. He found one substitute in clay, of which he made bricks, burning them so that they became as hard as stone, and another in concrete, which is really an artificial stone made by man.

By studying and experimenting it was discovered that a cement could be formed, which, if mixed with water and poured over grains of sand, stones, and other materials, would, as it dried and hardened, bind them together almost as strongly as the cementing materials of nature bind the

grains of sand in the sandstones. This cement, in many parts of Europe, is known as Roman cement because the Romans used something like it in their building construction. In our country it goes by the name of Portland cement or hydraulic cement because it is one of the rock cements which will harden to stone under water. There



Concrete house under construction.

are other hydraulic cements, but the Portland cement is most commonly used in making concrete or artificial stone.

This Portland cement consists of rock containing limestone and clay, or marl and clay, which is ground so fine by means of machinery that the grains of dust thus made will pass through a sieve which has ten thousand holes in each square inch of its surface. When the proper rock has been found it is blasted or dug out, and then reduced to a powder. The mixture is run into driers, which

are long cylinders of steel from six to eight feet in diameter. They are lined with fire brick and are heated red hot. They are turned around by machinery, and are so inclined that, as they turn, the cement mixture gradually rolls down over the hot brick until all the moisture has been removed from it. It is now again ground, the work being so carefully done that the materials of which the powder is composed are of just the proper proportions.

In making concrete this powder is mixed with sand and broken stones, and water is poured over it. The mass is turned over and over by machinery or by hand until every grain of the sand and every fragment of stone are covered with a film of the cement paste. The whole is now packed together in blocks or molds of the shapes desired, and when it hardens it has all the qualities of stone made by nature. It is in fact stone cemented together by man.

It is of such stone that a great deal of our modern building is done. Of its foundations are made, great columns erected, and the pillars which support our mightiest bridges are built. The streets of many of our cities are paved with it and our concrete floors, if they were all brought together, would cover thousands of acres. The cement employed is in such demand that millions of barrels are annually sold and its use is rapidly increasing from year to year. Indeed, some of our new homes are now being built of concrete throughout, and not a few of them have walls of solid concrete. Ornamental work of this material is largely used, the buildings so finished looking as though they were decorated with stone carvings.

Another form of artificial stone is the mortar used to unite brickwork and other masonry. This may be com-

posed of certain amounts of sand and lime mixed with water in such a way that it can be spread over the stones or thrown in between them; or it may be of sand and Portland cement and in some cases of plaster, which is really a form of lime. The lime-and-sand mortar is not so hard as



Lime kilns, San Juan Islands, Puget Sound.

sandstone and is less durable. Cement mortar is, if properly made, equal to stone; whereas plaster is much softer and is used chiefly in fine work and in places not exposed to the weather.

Mortars and rock cements of various kinds have been used for building as far back as man can remember. The huge blocks on the outside of the Great Pyramid were laid in a mixture which contained gypsum or plaster of Paris, and the Colosseum was largely of concrete.

As to plaster of Paris or burnt gypsum this was a part of most of the mortars used by the ancients. Later on it was employed in Europe, and a curious story is told in connection with the vast beds of gypsum which lie not far from Paris as to how a Frenchman discovered its value as a cementing material. One night a shepherd of that region cooked his supper upon a fireplace, which he made out in the open, of blocks from these gypsum beds, mixed with the other rocks lying about. His fire burned the gypsum to plaster of Paris, and, as he was about to leave, a rain came on, so wetting the plaster that it melted and cemented together the other rocks of the fireplace. In this way gypsum was found to be valuable, and the Paris deposits are now mined, roasted, and ground for shipment all over Europe. They are largely employed in cements, and in making plaster casts, including statuary of all kinds, and also in decorating the interiors of buildings.

In burning gypsum rock to make plaster of Paris, the furnace is made of the blocks as they come from the quarry, the fuel being put in while the furnace is building. Wood, coal, or coke may be used, the smoke going off through passages made for the purpose. The roasting lasts for ten hours, after which the burned pile of rocks cools for five or six days, when it is ready to fall into powder. It is sometimes beaten fine on the ground, and sometimes run through steel mills which grind it to plaster of the fineness required.

Excellent gypsum is now found in many places. France produces the most, but a great deal is mined in the United States, and especially in Texas, Michigan, New York, and Iowa.

14. BRICK STRUCTURES OF ANTIQUITY

"And the whole earth was of one language and of one speech.

"And it came to pass, as they journeyed from the east, that they found a plain in the land of Shinar; and they dwelt there.

"And they said one to another, Go to, let us make brick, and burn them thoroughly. And they had brick for stone, and slime had they for mortar."

WE have all read the story of the Tower of Babel, of which these verses from the Bible are the beginning. It was started by the Sons of Noah and it is related that they expected to build it up to Heaven, when they were suddenly stopped by the confusion of tongues. You may read all about it in the Book of Genesis.

That was more than four thousand years ago, and we thus see that man had even then learned how to use bricks of burnt clay as a building material. The walls of the great city of Babylon which stood on the Euphrates not far from the site of this Tower were made by some of the descendants of these builders. Herodotus, the oldest Greek historian, tells us that they were composed of the clay dug from the trenches outside, and that they were burnt bricks. He says that the walls were fifty-five miles long, three hundred and forty feet high, and eighty-five feet in thickness, inclosing a city of wide streets with houses of three or four stories and many temples and palaces.

For centuries Babylon was the greatest city of the world. It was the capital of King Nebuchadnezzar, who cast the three Hebrews into the fiery furnace and who afterwards went mad and ate grass. Its doom was foretold by the handwriting on the wall during the days of

Belshazzar, who succeeded Nebuchadnezzar. A little after that the city was conquered by Cyrus the Persian and Xerxes robbed the temples of their golden statues and treasures. It gradually fell into ruins, and became buried from sight by the dust and dirt of the ages.

Within recent times, however, men have dug down under the soil and found some of the bricks and other materials which once formed a part of the city. Many of the bricks were glazed in the burning and their colors are red, yellow, and blue; they are as bright as when they were made. Some of the burnt ones are thirteen inches square and three inches thick, or more than six times as large as the common red brick of our buildings. The Babylon bricks, used for the corners of the walls, were triangular in shape, and wedge-shaped bricks were employed for the arches. Some of those found have the signature of Nebuchadnezzar stamped on them, and from the marks on others we can tell the dates of many of the temples and palaces of that great city. The bricks were laid up in clay mud, lime mortar, and bitumen, and some in hot asphalt. Only the outside of the walls was composed of them, the interior being filled with sun-dried brick consisting of wet clay kneaded together with finely chopped straw.

Bricks made of sun-dried clay were probably employed for building long before man learned how to burn bricks. Going back to the Bible we find that the Israelites were forced to make such bricks in the days of Pharaoh. In the first chapter of Exodus we read:—

“And the Egyptians made the children of Israel to serve with rigor:

“And they made their lives bitter with hard bondage in mortar, and in brick, and in all manner of service in the field.”

A little farther on it is related how Pharaoh required them to gather their own straw from the fields, and notwithstanding this to make as many bricks a day as when the straw was furnished them. One passage is:—

“Ye shall no more give the people straw to make brick as heretofore: let them go and gather straw for themselves.

“And the tale [number] of the bricks which they did make heretofore, ye shall lay upon them.”

The only brick material in Egypt is the mud of the Nile; and the Israelites used this mud, mixing it with straw and turning it out in molds or shaping it up with their hands in much the same way as bricks are made in Egypt to-day. The houses of the common people are still composed of such materials, and should we go to Egypt we might find here and there along the Valley of the Nile shallow pits filled with mud through which water buffaloes are being driven back and forth. Some straw is thrown into the mud, and after a time this goes through it so that when it is taken out and shaped in the molds, the straw aids in holding the mud together. The bricks are put out in the sun to dry, and are then laid up in mud mortar.



“The only brick material in Egypt is the mud of the Nile.”

CARP. HOUSES — 9

Similar brickmaking goes on in many of the oases of the Sahara, in Persia and Arabia, in India, and in other parts of the globe where the rains are not frequent and building materials are scarce. We find houses of sun-dried bricks in Mexico made of adobe, and the remains of adobe houses still exist in Colorado, Arizona, New Mexico, and California which are centuries old. Some of them are more than three hundred years old, and nevertheless are still used.

But suppose we cross the Pacific Ocean and take a look at some of the brick buildings of China. Out in the country we shall find huts of sun-dried mud, and in the cities vast numbers of buildings made of bluish-gray bricks, being roofed with tiles of the same material. Almost all of the cities are surrounded by brick walls. Peking has a wall which is forty feet high. It has towers at the corners and here and there along the great structure; and all are composed of brick. Standing upon this wall we look over a city containing more than a million people, the most of whom live in brick houses; and off at one side, inside other brick walls, are the palaces of the Emperor and his family, the roofs of which are of yellow tiles, as smooth as china, which shine like gold under the sun.

From Peking we take the railroad which goes northward through the Nankow Pass into Mongolia to see the Great Wall of China. After a few hours' ride we come to a mighty wall made of these same blue bricks, only of a larger size. The wall is as high as a three-story house and twice as wide as the ordinary city sidewalk. We see it climbing the mountains and going down into the valleys, extending on and on as far as our eyes can reach. It begins at the

sea and runs over mountain and plain along the border of North China for a distance greater than from New York to the Mississippi River. It was put up as a defense against the savage people who lived on the other side of it, some parts having been built about two hundred years before Christ came.

The Great Wall is a mass of earth and stone mixed together, and faced on each side with gray or slate-colored brick, the material between being so packed that the whole is in most places as solid as stone. We climb to the top of the wall and, walking along it, find a place where the mortar has crumbled away and the bricks have come loose. I lift one of the bricks. It weighs twenty pounds, or about as much as some of our baby sisters; and measuring it we find that it is fifteen inches long, seven inches wide, and over three inches thick. The greater part of the wall is made of such bricks and it is said that they were often burned at clay beds miles away



"I lift one of the bricks."

and carried on the backs of sheep, goats, and donkeys up the hills to the masons on the wall.

Going on with our journey, we at last come to Italy, a country where bricks were made ages ago. They were in use in old Rome and the ruins of that city still contain many thin bricks of red clay. If we would see these bricks in the buildings we can do so best by going to Naples and out to Pompeii. We are now right under the volcano of Vesuvius, out of whose top the vapor is rising in clouds from the brimstone fires which are boiling and seething within. It is more than nineteen centuries since the little city in which we are standing was as alive as any of our towns of to-day. The carpenters, stone cutters, and masons were working away. New houses were building, and the people were living in comfortable homes of brick, stone, and marble. Chariots drawn by horses were going on the trot through the stone-paved streets, the wheels running in ruts which are still to be seen. Here and there in parts of the city the children were playing and in other places they were going to school. The life of a thriving town was in active operation, when, all at once, Vesuvius burst forth, throwing out streams of molten lava which in floods of fire rolled down the sides of the mountain.

At the same time the air was so filled with ashes that the sun became dim, and the people believed an age of perpetual night had set in. The ashes fell on Pompeii, and continued to fall until it was buried from view. Such of the people as could escape did so, but over two thousand were buried. The city was so covered that no signs of houses, theaters, temples, or other buildings were left. It was so far under the ashes that as time went on its very

existence was forgotten, and it was not until many centuries later that men began to dig the earth away and find what was left.

Since then a great part of Pompeii has been uncovered, and we can now tell just what kind of houses the people of that time had and how they were built. We stroll in and



In Pompeii, Vesuvius in background.

out through the dwellings, finding brick walls here and there. Many of the homes were plastered, and upon the walls are paintings in the brightest of colors. There are bathrooms made of brick, and a brick bakery, in the ovens of which were found loaves of bread, when the earth was dug away. Some of the finer houses were floored with tiles and not a few with mosaic, the vestibule of one having the picture of a dog tugging at his rope and trying to get loose. Under the picture are the words: "Cave Canem!" meaning, "Beware of the dog!"

Crossing from Naples to Algeria in Africa, and making

our way south through that country, we find not far from the Desert of Sahara a half-buried city which was larger than Pompeii. This was Timgad, a thriving colonial town of Imperial Rome, which was deserted, allowed to

fall into ruins, and finally buried by the sand and dust of the desert until the greater part of it had disappeared. The covering is now being taken off and we find brick houses there much like those of Pompeii. There are also temples and dwellings made partly of marble, a marble theater and forum, and an enormous bathhouse of burnt brick. The latter covered almost two acres, and was heated by flues



"This was Timgad, a thriving colonial town of Imperial Rome."

which ran under its floors. It had large swimming pools and hot and cold plunges, as well as courts where the bathers wrestled and played games of various kinds. We sit down on the marble seats running around the hall, and try to imagine how the little boys of Timgad enjoyed them-

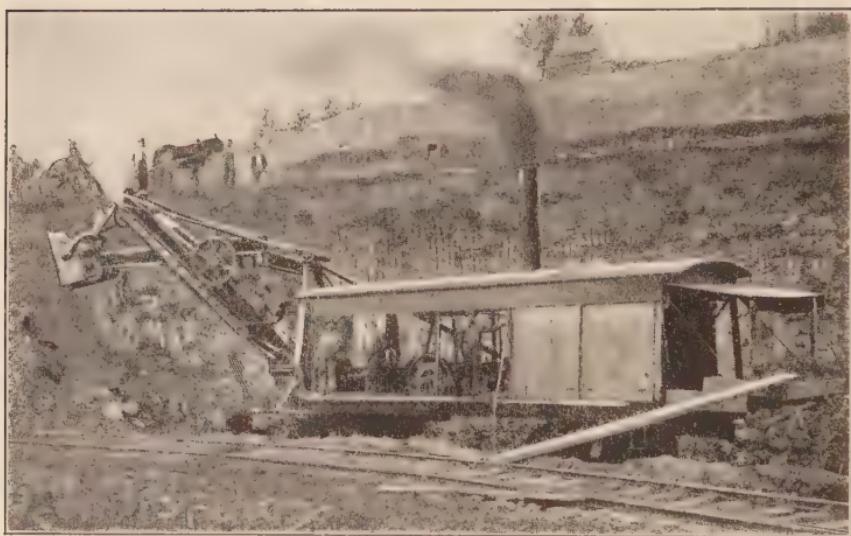
selves here when Europe was covered with woods and our ancestors were living in huts and sleeping on straw.

It was the Romans who first carried the art of brickmaking into Germany and Great Britain; but the people there seem to have forgotten it as soon as the Romans left. It was not until well along in the Middle Ages that England began to build houses of brick, although it is said that a few bricks were molded under the direction of Alfred the Great. During the reigns of Henry the Eighth and Queen Elizabeth, there were many brickyards, and from then on the English employed bricks as a building material. They were using them when our country was first settled; and some of the richer of the colonists brought burnt bricks across the Atlantic Ocean to America and built houses of them.



15. OUR AMERICAN BRICKYARDS

WE need not travel from home to find out how bricks are made. Our own country uses such vast quantities of them that nearly every town has its brickyard. There are more than twelve thousand such factories in the United States, and they turn out altogether something like twenty-five billion bricks every year. There are single yards which make one million a day, and others which have machines that will turn out one hundred thou-



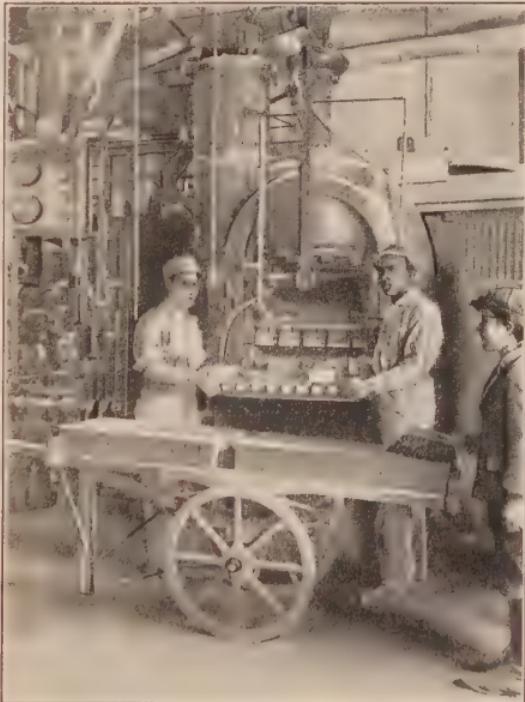
Loading brick clay with a steam shovel.



sand bricks within twenty-four hours. There is an establishment in New England which loads its clay with steam shovels and has huge traveling cranes to carry the bricks from one place to another. Its brickmaking machinery is moved by electricity.

The bricks we make are of about one hundred different varieties. They are of all shapes and sizes, some hard and some soft. They are of many colors, and often beautifully glazed. Some kinds are used for pavements, and others in mantels and ornamental work. We have pressed brick, fire brick, and vitrified brick. The fire brick is used in our large buildings of many stories, being put in between the beams and joists to make them fire-proof. Vitrified bricks are employed in street paving as well as for other purposes. They are made by grinding up hard materials, such as quartz, spar, shale, and fire clay.

Common brick is composed of clay of various kinds, the character of the product as a building material depending largely upon the clay used. The clay must be freed from



Hydraulic brick press.

lumps, and ground up and thoroughly mixed. If the material is of a hard nature, it is first ground, and after



Molding bricks by hand, Mexico.

that passed through a screen into a pug mill or mixer. This contains knives by which it is cut and mixed with water until it is just right for bricks. The clay goes from the pug mill into the brick machines, from which it comes to the cutting tables through a die, in the shape



New York water front. More than half of the visible building material is architectural terra cotta.

of clay bars. These bars are cut into bricks by fine steel piano wires, working automatically. The bricks are then carried on a traveling belt to other machines, which square their corners and edges, make them smooth, and print upon them any lettering desired.

If they are intended for rough brick, they are now carried on to the drier, which is a series of tunnels built of brick, and heated by a furnace, or by steam pipes or a blower. These tunnels are about four feet wide, five feet high, and one hundred and twenty feet long. The mud cubes are taken into them on little cars, and they remain there for twenty-four hours, when they are thoroughly dried. Each of these tunnels will hold about five thousand bricks at a time.



Terra cotta building.

When the bricks come from the tunnels, they are ready for burning. This, in the large yards, is done in ovens, each ten or twelve feet high and thirty feet in diameter. After the bricks have been piled up in the ovens an intense heat is admitted by blowing in the air from the furnaces, which are so hot that the draft bathes the interior of each



The Witch Doctor (terra cotta). School of Medicine,
University of Pittsburgh.

oven with a solid sheet of twisting flames, turning the clay to a red or white heat. The bricks are kept under this heat for from a week to ten days, when the fires are withdrawn, and they are allowed to cool.

In other brickyards where the clay is of a different nature it is first ground and mixed with water. It is then pressed into wooden molds, and from them goes on to the driers and the kilns. In the smaller brickyards the clay is sometimes mixed in a pug mill moved by horse power. It

is then molded by hand in rough wooden molds of the size and shape of the brick desired. Such bricks are often dried out in sheds and then placed in kilns for firing. After ten or fifteen days the fires are allowed to go down, and the bricks are ready for the markets. In the ovens wood or coal or even oil may be burned.

It is in much the same way that the terra cotta employed for ornamenting our buildings is made, save that the mixing and burning the clay must be more carefully done. In making tiles the clay comes out in thin bands which are cut by wires and then pressed into any shape that may be desired. Curved roofing tiles are often formed by bending the clay by hand over a leather saddle, the nail holes being punched in by hand. The tiles which are so beautifully glazed are taken out when half burned, and dipped into a mixture which, when they are fired again, gives the beautiful glass colored effects that we see in fine roofing.

The tiles for mantels, hearths, and for the walls and floors of bathrooms are made in much the same way. The fronts of buildings are often decorated with tiles. Some of the finest of such buildings are in Italy, one of which, known as the Hospital of the Innocents, has a decoration of round tiles, each of which represents a beautiful baby. This design was made by Andrea della Robbia, who was alive at the time America was discovered. Much terra cotta is now similarly used in ornamenting our public buildings, great figures like that of the Witch Doctor on the University of Pittsburg being made of it.

The ovens or kilns for terra cotta and tiles have an intense heat, the hot air coming in at the top and going down through the clay. In some of the ovens the tem-

perature is said to reach twenty-five hundred degrees Fahrenheit, a heat so intense that we cannot comprehend it. Indeed, the fuel used in brick and tile making costs many times as much as the clay itself, while the other materials which are sometimes mixed with the clay often cost more than the clay.



A tile from the Hospital
of the Innocents, Flor-
ence.

16. IRON

HAVE you ever thought what an important part iron has in our homes? It forms the basis of the whole building industry. From it are made all kinds of machinery, and every sort of hand tool. It gives us the ax and saw of the lumberman, the hatchet and plane of the carpenter, and the hammer and trowel of the mason. From it come the nails and screws which hold our dwellings together, the hinges upon which the doors swing back and forth, and the locks which close them at night. Many of our homes are roofed with sheets of iron, coated with tin or zinc. Some of them are plastered on iron lathing, and some have steel ceilings and floors. Moreover, the largest of our city

buildings, as we shall see later, are almost altogether of steel. They have a framework of steel, and contain little else than things made of that metal, excepting the stone, brick, and plaster used as a coating to keep out the weather and preserve the iron from rust.

We warm ourselves over iron stoves, or perhaps over iron radiators through which steam or hot water flows from an iron boiler on the floor below. Our meals are cooked upon iron stoves fed with coal by iron shovels and stirred with iron pokers. The water for our baths is made hot by such stoves, and in many of our dwellings it is carried through iron pipes to a bathtub of iron, coated with a white enamel, which makes it look like china. We sleep at night upon steel springs, and that we may rest the better screen our windows with iron wire cloth to keep out the flies and mosquitoes.

Can you imagine a world without iron? If we had none at all, machinery of all kinds would soon disappear, our occupations would change, and all sorts of mechanical labor, as we know it, would vanish. We should have to go back to hunting with bows and arrows; to plowing with forked sticks; or to grazing sheep and cattle for a livelihood. If we wished to travel on land we should have to walk, or ride upon horses, donkeys, or mules, or on carts drawn by them; and if we went by water, it would be in dugouts, canoes, or sailing ships, although it is doubtful whether ships could be made without this metal to put them together. Our houses would dwindle to huts roofed with thatch or to the other rude shelters dwelt in by half-civilized peoples. Indeed, it is impossible to conceive how poor a world without iron would be.

It is, therefore, no wonder that the mining of iron ore and the making of iron and steel and the things derived from them have become about the most important of industries. They are more or less carried on in all civilized lands; and especially where the people have the ma-



The Hanyang iron works in central China.

terials and skill needed for them. In this respect the United States is ahead of all other countries. We have vast iron deposits in many parts of the Union, and also the coal and limestone needed to mix with the ore for making pig iron. We have more than fourteen thousand different establishments, which are engaged upon the various manufactures of iron and steel, and our capital

employed in such industries amounts to several billions of dollars. We have about one million men who are always working upon such manufactures. They are paid every year something like five hundred million dollars in wages, and their annual product sells for over two billion dollars. We may appreciate these amounts better when we consider that the money paid for wages is enough to give each man, woman, and child in the United States a present of five dollars every Christmas; and that if we had to buy an equal share of the iron goods made in one year we should need twenty dollars apiece to make the purchase.

But before we go to the mines, let us have a little talk as to how iron was used in the past. We cannot tell when it was discovered; but from Genesis, the first book of the Bible, we know that Tubal Cain, who lived several thousand years before Christ, was not only a worker in iron, but that he taught others how to make things of iron and brass. All through the Bible iron is mentioned. It was used for plows, swords, and chariots; and for tools of various kinds, including those employed in house-building. We know that the ancient Egyptians had some knowledge of the metal, for a piece of iron has been found in the Great Pyramid, and Herodotus tells us that iron tools were used in making that structure. The Greeks had iron long before the Christian era, and the Romans had various tools of that metal. During the Middle Ages and especially at the time of the Crusades, steel, which as we shall see later is only one form of iron, was so well known that lances and armor for both men and horses were made of it. The warriors went to battle clad in iron and some wore, under

their armor, shirts of fine steel links, so skillfully joined that they fitted the body as though knitted together.

As to Asia, we find that the people there have been acquainted with iron so long that they cannot tell when it first came into use. Near Delhi in Hindustan, I have seen one of the oldest of all iron monuments. It is an



Iron dome of the Porcelain Pagoda now used as a fountain.

iron column which is supposed to have been erected as a pillar of victory by some warlike people who fought in India over two thousand years ago. It is as big around as a flour barrel; it rises twenty-three feet above the ground and is sunk many feet below it. It is in the mosque known as the Kutab Minar.

You may have read of the Porcelain Pagoda which the Chinese built during the same century that Columbus dis-

covered America. It was situated at Nanking, near the Yangtze River. That tower had a dome of cast iron. The structure below the dome was of porcelain bricks as smooth as the finest of china. It had eight sides and nine stories and it rose to a height nearly half that of the Washington Monument. At every one of the stories were little metal bells hanging to the rafters, which extended beyond the walls in such a way that they tinkled when swayed by the wind. The iron dome, plated with gold, could be seen for miles up and down the valley of the Yangtze River. The Porcelain Tower was thrown down at the time of a great rebellion and its beautiful bricks have disappeared. The iron dome is still in existence, and I photographed it during one of my recent visits to China. It is now used as a fountain, having been turned upside down and set into a foundation of marble. That mass of iron is so large that it would cover the biggest haystack, and it might make a fine bathtub for an elephant.

It is interesting to know something about the first use of iron in our own country. When our forefathers landed, the Indians had no tools or weapons made of this metal, and it is probable that they were not acquainted with its value. The white men, however, soon began to prospect for ores, and as their settlements increased iron deposits were discovered here and there not far back from the coast. They began to use the iron, and erected little furnaces and smelting works, as well as rude forges and mills. In these they made tools and building materials of various kinds, although England forbade them to do so, as she wanted them to buy all such things from her.

After our War of Independence the iron industry rapidly



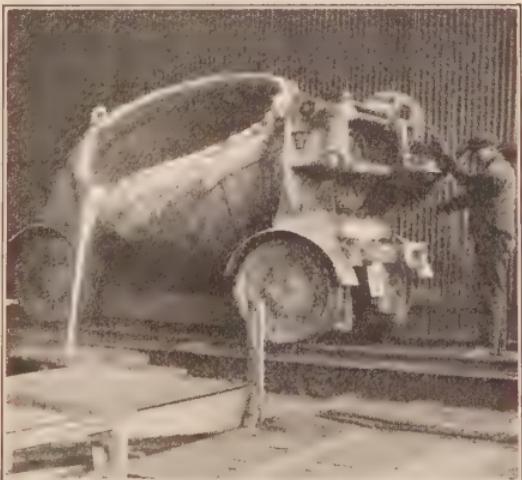
Iron works, Pittsburg.

developed, and in 1810 we produced over six million dollars' worth of iron of various kinds, of which about one third came from Pennsylvania. At the same time we began to make steel, and from then on our production of these articles was so rapid that we soon became one of the leading iron countries of the world, and within recent years have far surpassed any of the others.

But what is this metal that has so much to do with our shelter, and with almost everything that we make or use? Iron ore exists in many minerals and rocks, and sometimes gives a red or yellow color to the soil. The earth washings often contain so much iron that they discolor the streams. The water takes up small particles of the ore just as it takes up salt or sugar, and as it goes on through the earth it drops some here and there. It is from such droppings that the iron deposits which are mined have been formed.

As to the metal itself we shall have no trouble in finding good specimens of it. It is kept in every hardware store or blacksmith shop in the shape of things made of cast iron, wrought iron, and steel. Each of these is composed chiefly of iron but all differ in many ways, according to the treatment the metal receives after it is taken out of the ore. Cast iron is hard, and breaks easily. It can be melted but not bent, forged, or welded. A broken stove lid or any other casting will show us its nature. Wrought iron is comparatively soft, and it can be twisted and bent again and again without breaking. It may be welded and pounded or forged, but it will not melt except under great heat. This is the character of the horseshoe which the smith shapes so that it will just fit the hoof, or of soft wrought iron wire, which bends so easily that one can tie it into a knot. Steel can also be welded and forged. Moreover, it can be melted, and, by tempering, can be made hard or soft as desired; it can be made so hard that it will cut through wrought iron with ease.

From cast iron, wrought iron, and steel, and combinations of them, tools, machinery, and building materials are made. They all come from the ore, being produced through different methods of



In a blast furnace, Pittsburg.

smelting and of treating it, after it has been mined. We shall learn more of this as we visit the mills and the furnaces.

17. MINING IRON

THE first of our journeys will be to see the ore in the mines. Where shall we go? We have beds of iron ore scattered throughout the Union, and the mineral exists to a greater or less extent in all of the states. It is commercially mined in twenty-six states and territories; and we have some regions where it is found in such abundance that thousands of men are kept busy taking it out of the earth and loading the cars and ships which carry it to the smelters.



Inside of a Michigan ore mine.

Michigan, Wisconsin, and Minnesota. They are in five little ranges of mountains from fifteen to one hundred

miles back from the lake and so high above it that the ore can be taken by gravity down to the vessels. For this purpose railroads have been built, and the ore cars from the mines are carried out upon trestle works, connected with which are huge bins or pockets into which the ore is dropped. These pockets are high above the decks of the ships as they anchor for loading, and by opening them the ore falls through chutes right into the holds.



The steam shovel is really a great dipper.

Some of the ore about Lake Superior lies near the surface, being covered only with a thin skin of earth and rock. In such places the earth is taken off by steam shovels, and hauled away on the cars. The ore itself is then broken and loosened by blasting, and great shovels do the loading. This is open pit mining, and it is an interesting sight. The steam shovel is really a great steel dipper or scoop fastened to a long arm or handle attached to a steam engine on wheels. The dipper is about as big around as a hogshead.

It has big steel teeth on one side of its rim which cut into the ore, and its bottom is so arranged that it can be dropped, allowing the contents to fall out. The engine raises and lowers and moves the shovel about as the engineer wills. The engineer pulls a lever and the great teeth go down into the ore, taking a mouthful of five tons at one bite. Another lever is pulled and the arm rises and carries the load around until it hangs over the car on the track. A third motion and the bottom or underjaw of the shovel drops, and the ore falls into the car. The work is so rapid that one shovel can do as much as several hundred men, laboring without it, and a car of fifty tons can be loaded within a very few minutes. A single shovel sometimes loads two thousand tons in one day.

Different methods must be employed for ore which lies far underground. In such mines shafts or pits are sunk through the earth to the ore beds, and tunnels are dug and blasted out into them. The miners take up the ore and load it upon little steel cars which are carried to the surface on elevators or by wire ropes and dumped into other cars which take it down to the steamer. The finest of machinery is employed in such mines. They are lighted by electricity, and compressed air and steam work the pumps, drills, and hoists.

The transportation of the ore from the mines down the lakes to the places where it is turned into iron and steel is another great industry. It employs so many vessels, during the eight warmer months when the lakes are not frozen, that the tonnage they carry in that time is greater than that which comes into any ocean port of the world in a whole year.

The vessels are built especially for the traffic, and some are of great size. To give an idea of their loads I may say that if you should fill a business street fifty feet wide, for four hundred feet, or almost one block, up to the tops of the second story windows with solid ore, it could not hold more than one big steamer's cargo. Some of the ships take twelve thousand tons at a time, and altogether the amount carried down in one season often weighs



Cleveland ore docks.

twenty or more million tons. Of this about one fourth goes through Lake Michigan to Chicago and Milwaukee, and most of the remainder to the ports of Lake Erie, or to places in the interior where the furnaces and smelting works are.

But why is the ore taken such long distances before it is smelted? One would think it would be cheaper to make the iron right at the mines. It might be so if nothing more than the ore were needed in the manufacture of iron. It is necessary, however, to have two other ingredients to mix

with the ore in the furnaces in order to get the iron out of the ore. These are coal and limestone. Now there are no great coal beds near the Lake Superior mines, and it has been found cheaper to carry the iron down the lakes to the coal than to carry the coal to the iron. There are great coal deposits in Pennsylvania, West Virginia, and Ohio, and plenty of limestone as well, so that in those states the smelting can be done cheaply. Therefore large smelting and iron manufacturing industries have grown up in Cleveland, Pittsburg, and at other cities which are within easy reach of the coal and limestone. For similar reasons Milwaukee and Chicago have large smelting works.

We have, however, some places which have extensive deposits of iron, with coal and limestone hard by. Such, for instance, are the conditions about Birmingham, Alabama, where great smelters have been built for reducing the ore. The iron, there, lies close to the surface of the earth, and is taken out through tunnels which are driven into the sides of the mountains.

Suppose we enter one of the mines. There is a railroad running down into it, and we get on the car with a group of sooty miners going to work. As we step out at one of the levels our guide hands us candles, and shows us the bed or vein of ore they are mining. It is a sandwich of gray iron stone between walls of slate and other rock. It ranges in width from eight to twenty-four feet, and slants as it goes downward.

As we move along we hear the boom, boom, boom of the blasting powder. The miners are drilling holes in the rock, and putting in dynamite sticks, to which long fuses are fastened. As they light the fuses the men warn us

to run, and we barely reach a safe place before an explosion occurs. The earth shakes and the air so quivers that it blows out our candles. Returning we find that a great mass of ore has been loosened and broken in pieces. It will now be loaded on the cars, and in a short time will be on its way to the surface.

But before leaving the mine let us take a look at the ore. It is sometimes called iron stone, and seems just like stone save that it is heavier than any rock we have handled before. It shines where it has been broken and is of a silver-gray color. In other mines the ore is red, brown, or of a yellowish hue.

In some of the iron deposits the ore lies in the shape of nuggets or lumps, and in others in the form of a powder or in beds of black sand. We might collect all the varieties together, and if we knew nothing about the processes of getting the iron out of the ore we could not use it for building. It is true we might be able to pile lumps of the iron stone one on top of another, and by using mortar or cement put them together in walls, or we perhaps might mix the black sand with cement in making concrete, but otherwise we could do nothing.

Iron is never pure as it lies in the earth, although in Greenland a ledge of almost pure volcanic iron is known to exist, and some of the meteors which have fallen upon our planet are of iron and nickel. The iron from the mines is always mixed with rocks and other minerals, and often to such an extent that it would cost too much to extract it. It is only through the machinery and processes of taking the metal out of the ore, which man has discovered, that iron has become of value to us.

18. IN THE FURNACES AND ROLLING MILLS

WE have left the mines and are about to visit the great smelting works where the metal is taken out of the ore and reduced to pig iron. On all sides of us are huge furnaces, great black pipes of iron lined with fire brick. They rise upward for a hundred or more feet and where hottest are surrounded by chambers through which cold water flows. They have machinery for hoisting and filling them, on their sides and their tops. Connected with each furnace are gigantic stoves through which the blast of air passes before it is blown into the furnace to increase the heat of the coke burning within. There are also tall smokestacks, almost kissing the clouds, which furnish the draft; and shedlike buildings through which the blazing stream of molten iron flows as it comes out to be molded to pigs.

All about the furnaces are huge heaps of ore, limestone, and coke. The coke has come from coal which has for days been so roasted in ovens that the gases and other impurities have been cooked out of it, and it is now of the right nature to furnish the intense heat needed for smelting. Coke is much lighter than coal. We can find some at any gas works, the gas having been taken out of the coal that it might be used for lighting our houses.

As we look at the furnaces we hear the din of machinery. Cars and other conveyers are traveling to the tops of each huge pipe and dropping their loads into its mouth. They are taking up masses of the iron ore, limestone, and coke, and letting them fall so that they lie in the furnace one on top of another. The men know just how much of each to

use, and just how all should be fed. Additional supplies are put in every few moments, so that about six hundred tons of these materials are consumed every four hours. In this time one hundred tons or more of pig or cast iron are made, the larger furnaces often producing as much as six hundred tons in one day.

The furnace is not allowed to grow cool from the time it is lighted. The great heat is maintained day and night all the year through, and running water is kept flowing through the hollow chambers about it to prevent the heat from melting the walls. The temperature is so high that the iron ore and limestone soon melt into a fiery molasses-like mixture, and the whole mass turns to a fluid, which blazes and seethes and boils as the hot blast rushes through it.



Tapping a furnace.

After a short time gravitation begins to pull the different elements of the liquid apart. The iron is the heaviest, and gradually it sinks to the bottom, while the other materials, comprising the limestone and everything which is not iron, float above. By and by the iron has all settled in the lowest part of the furnace, and the slag, which is the name given to the other materials, lies on top.

The furnace is now ready for tapping. The first opening is a hole just above the level of the liquid iron, in order that the slag may flow off. It comes forth in a blazing torrent of yellow, sputtering and sending out sparks, and falls down upon the deep sand of the furnace floor, where



“See the golden stream of molten metal come out.”

little ditches have been cut at such a slope that they carry it off.

Now the slag has disappeared, and another hole at the bottom of the furnace is opened to let out the iron itself. See the golden stream of molten metal come out. It blazes and bubbles and sends up sparks like a skyrocket as it runs down through the sand. It is so hot that it almost blisters our faces, and we step back for fear the

sparks may fall on our feet. It continues to flow, winding its way through the channel made for it, until it enters a great bed or garden of sand. This is cut up into short ditches, each a little more than three feet in length, three or four inches wide, and of a little less depth. They are the molds for the pigs. After the iron flows into them it rapidly cools; it grows darker and darker; and its color changes, until it finally turns a blue gray. It hardens as it cools, and after a time, when the heat is all gone, the pigs are taken out and piled up until needed for the making of steel or for shipment to the markets.

The manufacture of pig iron is now carried on in many parts of the world. It has long been one of the chief industries of those countries of Europe which have iron deposits, and within recent years extensive smelting works have been erected in Japan, China, India, and in some other parts of Asia. In the United States, the industry is greater than anywhere else, and we are now smelting about half of all the pig iron produced by the world. We make so much every year that it has been estimated that it would take a train of cars reaching halfway around the globe to carry the load, and that if it were all made into telephone wire it might form a line from the earth to the sun. Tens of thousands of people are engaged in the industry, and the annual product has a value of several hundred millions of dollars.

Pig iron is the raw material for making all other iron and steel. It is hard and brittle, and it may be used for rough castings, such as stoves and other things which are to receive hard usage and which can be easily made by running the liquid iron into molds.

As the pig iron comes from the furnaces it contains many impurities, which must be taken out before it can be made into wrought iron or steel. In these processes, if the pig iron has been allowed to cool, it must be melted, and so treated as to drive the carbon, silicon, and other impurities out. In the great establishment where we are now, the cost of melting again is saved by taking the pig iron in the molten state to the steel works. In doing this the golden stream from the furnace is run out through a spout into five brick-lined tanks called ladles. Each ladle rests upon car wheels, and the five are joined together in a train, which so moves upon a track that they can be brought one after another under the spout of the furnace. Each ladle holds twenty tons, and the five will contain one hundred tons, or the amount of molten pig iron drawn off at one time.

We watch the blazing mixture as it pours into the ladles, and follow the train as it moves on, bubbling and boiling, over the track through the works. The iron first goes to the mixer. This is a huge kettle which holds perhaps two hundred tons. Here the ladles, one by one, are lifted by great cranes and their contents poured in, the idea being to render the whole of a more uniform quality.

The metal is now ready to be turned into steel. The old methods of doing this were slow, laborious, and costly. To-day, by the inventions of Bessemer and others, they have become so rapid and cheap that steel has largely taken the place of cast iron. All our tools are of steel, our modern buildings are of steel, and steel is employed for everything where toughness, strength, and elasticity are required. In making it, it is necessary to take the impuri-

ties out of the iron. In the Bessemer process this is done by blowing air through the molten metal in such a way that the sulphur, silicon, and other impurities are driven off, and some carbon is added, so that as the metal flows forth it is steel ready to be cast or forged into any shape that may be desired. There are other processes of making steel which yield much the same results, but the Bessemer process for a long time produced most of our building materials of this nature.

Now suppose we go to another part of the works and see the steel actually made. The molten metal as it comes from the mixer is emptied by machinery into an enormous iron receptacle shaped like an egg. It is perhaps the biggest egg ever made, and far bigger than the famous roc egg described in the Arabian Nights in the adventures of Sindbad the Sailor. This egg or converter is made of wrought iron, lined with such materials that the molten metal cannot affect them; and it is so arranged that when the iron has been poured in, a blast of air can be blown through it in from one hundred and fifty to two hundred different streams. As the air rushes through, the various gases and other elements of the melted iron combine and the stuff boils and seethes. A mighty volume of blazing gas and fire now spurts out of the top or mouth of the converter, and falls in a shower of sparks and fragments of molten slag, making most beautiful fireworks. These fireworks continue for about ten minutes, or until all the impurities have been burnt out and only the pure iron remains.

It is now too pure to make steel, and so a little other iron containing carbon and manganese is added, and at the

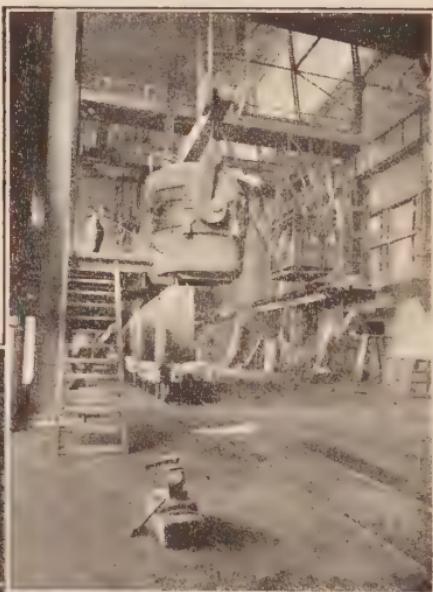
end the metal comes out as steel of just the right nature for tools, machines, and structural materials, such as we use in building. The steel is now run off into great molds, in which it hardens in the shape of huge blocks called ingots.

These ingots may be allowed to cool and be carried elsewhere for



Making steel by Bessemer process.

rolled this way and that until they are reduced to the shapes desired for making railroad tracks, bridge materials,



"The steel is now run off into great molds."

steel manufacture. Or they may be taken, as soon as they have become solid but still hot, and run through the rolling mill, being drawn thinner and thinner, and kneaded and

and buildings. Sometimes the steel as it comes from the furnace is cast into the forms desired. That used in our large buildings is generally rolled out into various shapes. It is sawed with steel saws, and is sheared and planed to the exact forms required for the structure.

In making wrought iron the pig iron is put into furnaces of a different character from that in which the iron is smelted. The wrought iron furnace is usually long and low, so that the iron can be stirred about or puddled, bringing every bit into contact with the air. As this is done, some of the impurities go off in gases. Sometimes iron is added which contains the other elements needed; and at the close the mass more or less pure is taken out in the shape of a ball or lump, or a bloom as it is called. This is put under steam hammers and pounded and kneaded, or it may be run through rollers until it is of the texture required. It is now of such a nature that it can be bent this way and that, or rolled out into sheets or plates or pounded to shape.

Indeed, the machines for making and handling iron and steel are of so many kinds that we cannot describe them. If you should go into a large hardware store you might find forty or fifty thousand different articles of iron or steel, and each would have been made by machinery somewhat different from that which produces any of the others. It will be enough for us to say that some of the machines are so strong that they will knead or roll an iron ingot weighing a ton as easily as our cooks knead dough for bread; and others are so delicate that they will draw out the steel into the hairspring of a watch or the needles our mothers use in mending our clothes.

19. NAILS AND SCREWS, LOCKS AND HINGES



HOW would you like to have a museum? We can each make one as we go on with our travels. We might entitle our collection "The Museum of House Building," and in it put all the pictures and other things we can find that will illustrate how our homes are made and the various materials in them. To do so we should go back over our travels, and collect photographs or drawings of the first shelters man used. We might get views of the tent dwellers, and of the savage homes of grass, cane, and leaves, and after that the log cabins and other houses of our colonial days. It will not be hard to find pictures of the Pyramid of Cheops in Egypt, the Colosseum at Rome, and of the great Chinese Wall or of the buildings now standing in the once buried city of Pompeii.

We can easily collect building materials. Any lumber yard will give us pieces of pine, oak, and other woods, and the stone-cutting establishments will furnish bits of marble, granite, sandstone, and slate. We have brick all around us, and many of us live near the materials used for making iron and steel. Coke is to be had at every gas plant, and if we have no iron ore near we can get some by writing to teachers or others in the towns at the mines.

For instance, take nails, which form one of the objects of our travels to-day. Let each of us collect as many kinds as he can and bring them along. I doubt, however, whether, all taken together, we can make the collection complete. There are more than three hundred

different kinds of nails used in building and they range in size from spikes as thick as our fingers and half a foot long, down to the little tacks in the carpets. Nails are made of many materials, although for the most part they are of iron or steel. There are copper nails, brass nails, and nails of zinc and galvanized iron. The wrought iron nail will bend easily, and the same is true of the nails with which the blacksmiths fasten horseshoes. Horseshoe nails have big heads and are sharp; they are so soft that the ends can be pinched off and pounded down where they come through the hoof. Most nails are made by machinery, but horseshoe nails are often forged upon anvils by hand.

It would be interesting to know who made the first nail. For a long time, we may be sure, men fastened their houses together with wooden pins, and to-day many of the shelters of uncivilized tribes are pinned together with wood or tied into place with fibers of one kind or another. This is true of the houses of the poorer of the Filipinos, whose roofs of palm leaves are tied or sewed to the rafters, the framework being fastened together by splints or strips of rattan. Many of the first houses of our country were built without iron, wooden pins and pegs taking the places of nails and spikes. President Jefferson made nails for sale on his estate at Monticello, and there were many other small nail factories in Virginia and Maryland.

The ancients used nails of bronze and some made of that metal have been dug from the Pompeian ruins. History tells us that a century or so ago every large town in Europe had its nail makers, who worked at that trade

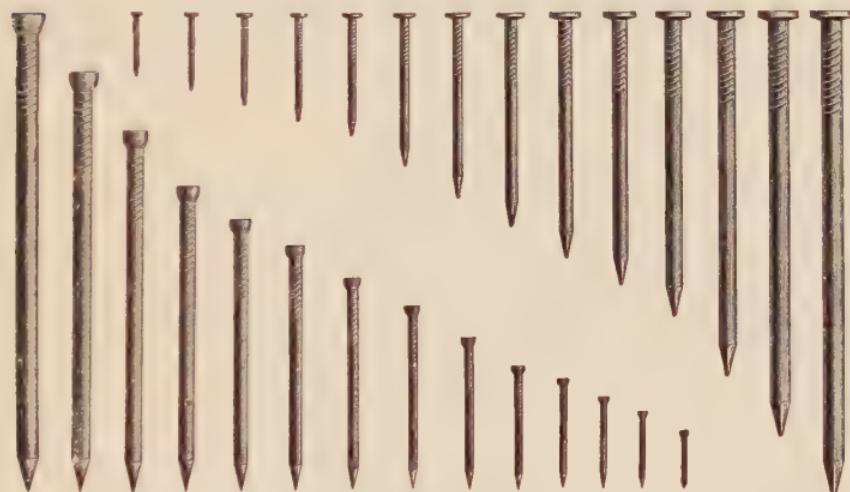
alone. Each man had his own little anvil and forge and he cut off and shaped the nails by hand one by one. There were certain places near the iron mines in England where whole villages did nothing else. Not only the men, but the women and children as well, worked at nail-making, and little boys and girls heated the thin rods of iron red-hot and cut and shaped them into such nails as the market required. In Birmingham, England, sixty thousand persons were so employed, and they used two hundred tons of iron a week.

At that time nail rods of the right thickness were rolled or cut out of wrought iron bars or plates. They were sold in bundles to these blacksmiths, who heated the rods and cut them into the right lengths for nails. Then each length was put into a steel vise with a bit of the iron projecting, and a few blows with a hammer flattened this end into a head and another blow or so made the nail sharp. Tacks and brads were made in much the same way.

Such methods were still in use everywhere in our colonial days; but ten years after we declared our Independence of England, a Massachusetts man, Ezekiel Reed, invented a cut-nail making machine. Soon after this other machines were invented and within a few years nails were everywhere made by machinery. We have now many nail factories, and some of them are making eight thousand tons of nails in a month. We have single machines which will cut out a thousand nails in one minute and others which make round or wire nails of drawn steel at the rate of five hundred per minute.

In the manufacture of nails of steel wire, the pig iron is

run through the Bessemer converter and then cast into billets about a yard long and four inches square. These are heated and drawn through one great pair of rolls after another, until they come out in long wire rods only three fourths of an inch thick. They now go through ten or more other rollers, growing thinner and longer until at last they are rods of steel almost twelve hundred feet long and only



Wire nails.

a quarter of an inch thick. During the drawing the rod moves faster and faster until when near the end of its journey it is traveling at the rate of thirteen hundred and fifty feet per minute, or almost fifteen miles an hour. It is done rapidly that the steel may not grow too cool during the process.

After this the rod is drawn by powerful machinery through holes in stout blocks of cast steel, the holes being the exact size of the nail wire required. It is now annealed, or heated to take out the strain, and is then ready to be

made into nails. It goes to the nail machine, entering it as wire and coming out in a stream of finished nails at the rate of from one hundred and fifty to five hundred per minute. The machine cuts the nails from the wire, points them, and pounds on the heads; all being done more rapidly than one could imagine. The threepenny



Tacks.

fine nails come out at the rate of five hundred a minute, and the very large ones at one hundred and fifty per minute. As soon as the nails drop, they are thrown into big revolving iron cylinders, where they are rolled over and over against each other and the sides of the cylinders,



Wire screw hooks.

until they receive the bright polish of the nails sold in our stores. They are now packed up in one hundred pound kegs, and shipped off to the markets.

As we go through the factory we ask what the word penny means when used in connection with nails; for the men always speak of nails according to size as three

pennys, four pennys, six pennys and so on up to sixty pennys. They show us that the nails grow larger with the numbers, and we learn that the penny has come from the word pound, and that they were originally called three pound, four pound, five pound nails, according as it took



Screw eyes.

a thousand of the nails to weigh so many pounds. For instance, it took one thousand fourpenny nails to weigh four pounds, one thousand tenpennys to weigh ten pounds, a thousand sixtpennys to weigh sixty pounds, and so on. In time the sizes of the nails became fixed, and the actual numbers were not counted.

Another interesting article used largely in fastening our houses together is the screw, which is now made of steel

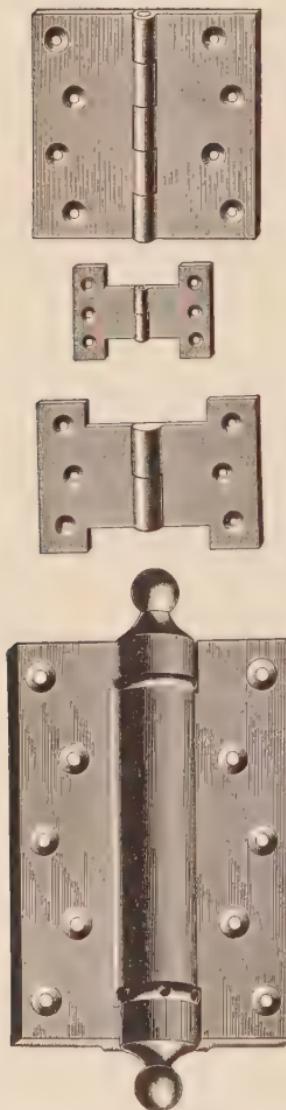


Machine screws.

in many different sizes. In such manufacture the wire is first drawn, and then cut, headed, and threaded by machinery so that it has the spiral point which enables it to work its way through the wood. After this the screws are polished, and packed up in cardboard boxes for sale.

But it will be impossible for us to examine every variety of iron that goes into our houses. There are so many that it would take weeks of travel to study them all. There

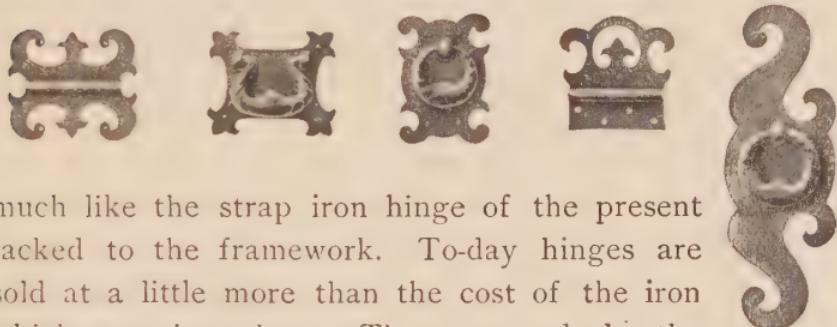
are some iron things, however, which are found in every house, and among the most important of these are hinges and locks.



The original hinge was probably a piece of vine or fiber put through holes made in one side of the door to tie it to the framework so that it could be swung back and forth. Later on leather was used in much the same way. Doors were also made with pivotlike projections at the top and bottom, which fitted into holes of the framework, and they were thus moved back and forth. An Italian cathedral which was built in the eleventh century has shutters of stone slabs which are hung by such pivots. During the Middle Ages many curious iron hinges were wrought on the forge. To-day all sorts of hinges are cut and cast out of iron and steel, and also from brass and other combinations of metals.



In our colonial days, when iron was so hard to get, many of the log cabins had doors with leather hinges



much like the strap iron hinge of the present tacked to the framework. To-day hinges are sold at a little more than the cost of the iron which goes into them. They are made by the millions, and we can find many kinds for our museum if we decide to collect them.

A more interesting article, however, is the lock, which has hundreds of shapes, including many curious contrivances to puzzle the stranger. The lock is intended to keep one's things safe from thieves, and sometimes from the gaze of curious persons who wish to learn about matters concerning which they have no business to know. Therefore it must be of such a nature that it cannot be easily opened, and the more complicated it is the better it serves the purpose for which it is made.

Locks have been used as long as man can remember. The Greek poet Homer, who lived ages ago, speaks of them; and Pliny, an ancient Roman writer, says that keys were invented about seven hundred years before Christ. The old-time Egyptians hung their



doors upon hinges of bronze, and they kept their jewelry in bronze caskets fastened by locks. The Romans had bolts and locks on their doors, and their money chests and jewel caskets were guarded in the same way. Some of their locks were so large that the key had to be supported while turning it, and others so small that they were mounted as finger rings.

The Chinese have locks which work on the principle of the screw, and may be screwed open or shut; and in some of their locks a bell rings as the key turns, so that they can tell by the sound if anyone is trying to open the door.

We have locks containing tumblers and springs and other contrivances on the inside which make it almost impossible for one who has not the right key to move them. We have time locks which cannot be opened except at the minute and hour fixed for doing so; and combination locks in which one must turn the key this way and that just so far and no farther each time. Sometimes the combination is composed of figures and sometimes of letters, so that one must spell out a word on the dial before the lock will spring open. We have also spring locks, sliding door locks, night latches, and dead locks in which no knob is used, the key alone being required.

Some locks are arranged so that they can be locked from the inside but not from the outside of the door, and some in such a way that one key will unlock a whole series of locks, but the individual keys will not open any of the others. Indeed, locks are now of all sizes and shapes, embracing a great variety of curious inventions. In the past they were wrought out almost altogether by hand. They are now made by machinery.

20. TIN AND ZINC

TO-DAY we are to investigate the use of certain water-proof metals. We may call them such, for they are used to protect other metals, and especially iron and steel, from the weather, much as our rubber coats protect us from rain. It is strange to think of putting overcoats on such tough, strong, and durable metals as iron and steel for fear they may grow sick through wet weather. But that is really the case. Iron and steel rust or oxidize when exposed to the moisture and air; and, if not protected, they will in time become weak and scale off so that they will finally fall into pieces.

It is therefore desirable to have some sort of weather-proof clothing to put over them. Now there are several metals which air and water do not affect so rapidly as they do iron and steel; and these are employed to cover the latter. Among the chief of such metals are tin and zinc, which we shall examine to-day.

We use tin for roofing and spouting, and for cups, pails, and pans of all kinds. Bathtubs are often lined with tin and the canning and certain other industries depend largely upon it for the vessels or boxes in which goods are kept until sold. There must be a vast deal of the metal, must there not?

Indeed, at first thought, one would think this the case, but it is not so. There are only a few places where tin has been found in large quantities. We shall see where these are farther on. All the tin mined on the globe in one year is only about one hundred thousand tons, while the iron and steel amount to much more than a thousand times

that. The tin, however, is seldom used except as a coating. The metal is such that it can be pounded out into sheets so thin that one thousand of them laid one on top of another would not be thicker than this book we are reading. Tin foil, such as is sometimes wrapped around cakes of sweet chocolate, will serve as a specimen of this for our house-building museum. Roofing plates are of iron with an even thinner coating of tin, and tin cups and pans are only iron, tin-plated. We shall learn that zinc is used in much the same way.

But let us take a rapid trip over the world and examine the tin ore as it lies in the earth. We shall find it in nuggets, grains, and dust, much like the placer gold that is washed out of the beds of the streams in some parts of our West. It also exists in lodes or veins in rocks, which must be pounded to powder to get the tin out.

Our first journey is on an ocean liner across the Atlantic to Wales in Great Britain. We go to Cornwall, where are tin mines which have been worked for two or three thousand years. The early Phœnicians knew of them, and both they and the Romans sailed out through the Strait of Gibraltar and across to Great Britain for cargoes of tin. Much of the Cornwall tin is mixed with copper. It lies in faults or breaks in the granite or slate rock, some of the veins being no thicker than sheets of paper and others many feet thick. In places the tin ore lies in large masses, and at one point we are shown a great bowl almost a mile in circumference and several hundred feet deep, from which about a million tons have been taken. The earth of that mine is soft, and much of the ore was washed out. In other mines the workings are now half a mile under-

ground, comprising miles of tunnels in which pumps are kept going to take out the water. The ore when it comes to the surface is sorted and ground to a powder. It is then washed to remove the earthy materials, and after that roasted and smelted and run off into bricks.

The grains of tin, or stream-tin as they are called, are



Tin mine in Malay Archipelago.

much like big grains of gunpowder, whereas, that found in the veins looks like silver or lead ore. The smelted bricks shine like silver.

From Cornwall we might cross the English Channel and take a run into Saxony and Bohemia, both of which produce tin; or if we had some months to spare we could go back over the Atlantic to South America and travel on the Amazon to its source high up in the Andes, not far

from which are large tin deposits. I have visited some about Lake Titicaca on the high plateau of Bolivia. That region has mountains in which tin, copper, and silver lie close together.

The tin is in veins which range in thickness up to six and eight feet and in depth to more than six hundred feet. The ore is taken out by the Indians. It is sometimes carried to the trains or the smelters on the backs of llamas, queer little animals which have wool like a sheep and necks and heads not unlike a camel. Each llama will carry only one hundred pounds of ore at a load, and if more is put upon him he will lie down and spit a sour, biting liquid at any man who tries to force him to move.

The most important of all the tin mines are in southeastern Asia. The total annual product of the world, as I have said, is about one hundred thousand tons. Of this perhaps one twentieth comes from Cornwall and three times as much from the Andes. Of the remainder seven thousand tons are produced in Australasia, and the balance, which is almost seven tenths of the whole, comes from the southern end of the Siamese Peninsula near the Strait of Malacca and the two little islands of Banka and Billiton lying between that Strait and Java. The mines on the peninsula now yield more than half of all the tin used. This product is known as Straits tin. It is found in grains, beds, and veins, and is often so mixed with earth and gravel that it can be mined by throwing streams of water against it through a hose worked by a pump. The gravel is then washed, in which process the heavy tin sinks to the bottom. It is now gathered up and carried to the furnaces, where it is smelted with charcoal and limestone and run

off into pigs or bricks of the size of a pound loaf of bread. The same sort of smelting is done in other tin regions.

As the tin comes from the smelters it is mixed with impurities. It often contains arsenic and iron, copper and other materials. It must be remelted and run off into refining basins, where it is stirred with sticks of green wood. As the wood moves about through the boiling metal, its sap is cooked out in steam, and this aids in separating the impurities from the tin. By and by, the other metals, inasmuch as they are heavier than the tin, sink to the bottom, and the molten liquid above, now almost pure tin, is drawn off into molds, where it cools. The tin is now known as block tin, and is ready for making tin plate.

In the meantime the iron must go through many processes before it is ready for its tin overcoat. The pig metal has already been smelted, and reduced to the right sort of iron for the plates. It has been passed through one set of rollers after another until it has reached the size and thickness of the plates to be used, and it has now to be so cleaned, smoothed, and polished that the tin will spread evenly over its surface.

In the first place, it must be perfectly clean. We have often heard of pickling cucumbers in vinegar. The tin makers tell us that they have to pickle the iron before the tin is put on. This is to take off the rust and scales. In this process the plates are bathed again and again in hot sulphuric or hydrochloric acid, being taken out between-whiles and washed clean and heated and cooled in just the right way to make them of the soft and pliable nature intended for roofing, or for bending them to the shape of tin cups and other such things. They are run through chilled

iron rollers, are polished with emery and oil, and then scoured with sand until they are white, clean, and bright.

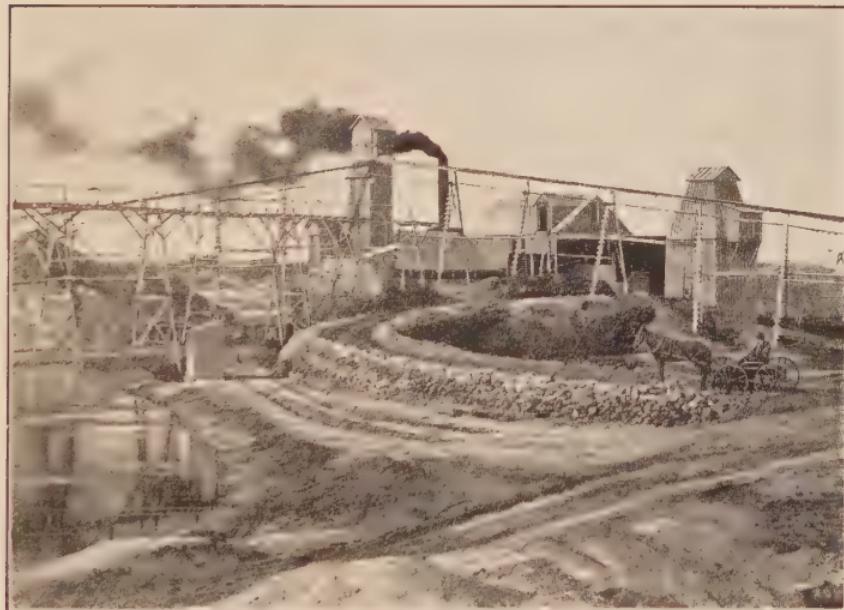
After they are ready for the tin, each sheet is dropped into a pot of melted grease and then taken out and plunged with other sheets into a bath of melted tin coated with grease. Some of the molten tin sticks to the iron plate, and the plate then receives a second tin bath in which the metal is purer. The tin-plated sheets are now wiped off with a brush, and put into the washpot. If there is too much tin on them, some is removed by giving them a bath of tallow and palm oil, the liquid being just hot enough to allow the surplus tin to run off. The sheets are next passed through troughs containing bran and meal, and are rubbed with flannel until they shine like a mirror. They are now ready for shipment to the markets.

Zinc is another waterproof metal largely used to protect the iron we employ in our dwellings. Many of our roofs are of galvanized iron, and in parts of the world where wood is scarce, whole houses, large and small, are composed of sheets of iron so covered. In making such iron the sheets are coated with tin by what is known as the galvanic process, and are then plunged into a bath of fluid zinc and certain other chemicals by which the zinc is left on the metal. The term "galvanized iron" is also used for iron which has been dipped in a bath of melted zinc, mixed with certain chemicals, which cause the zinc to fasten itself to the iron.

Vast quantities of the iron pipes used for plumbing are coated with zinc, and the same is true of spouting and fixtures of various kinds. If the zinc is put on thickly it forms an even safer protection against rust than tin. It

is largely employed in coating fence wire, and in all iron structures where painting is not desirable on account of the cost.

Zinc ore is more common than tin ore. It looks like lead ore and is often mixed with it. It is found in certain countries of Europe, and in great masses in Central Africa.



View in lead and zinc mine, Kansas.

It exists in many parts of the United States and especially in Kansas, Missouri, and Wisconsin. The center of the zinc-mining industry is Joplin, in southwestern Missouri. About that city great zinc deposits have been found, and more than one hundred million dollars worth taken from them. There was no city at Joplin before zinc was discovered, and that mineral is really the cause of the growth of the city. The common term for zinc ore used by the

miners is "jack," and so "jack" has built up the city. We have all heard of the "House that Jack Built," but Joplin is the *town* that "jack" built.

21. LEAD, COPPER, AND BRASS

"Oh that my words . . . were graven with an iron pen and lead in the rock forever."

THIS sentence comes from the Bible, and it was uttered by Job, thousands of years before Christ. It shows us that lead was already in use at that time and that the people knew much about it. The ancient Romans covered the bottoms of their ships with sheet lead which they fastened on with bronze nails. Their warriors used leaden bullets which they threw with slings. They had lead water pipes in their houses, and they made lead paints, which the great ladies used to color their cheeks.

To-day white lead, made by corroding lead in acetic acid, is the most common form in which lead is employed. Such lead, ground in oil, forms a waterproof coating for almost all our frame houses, and it is often employed to protect iron from rust.* It combines readily with linseed oil, and is the basis of some of the best paints which have yet been discovered.

We use lead in its metallic form for water pipes, joints, and plumbing of various kinds. In solder it aids in joining tin plates together, and it is also employed in the manufacture of glass.

Lead is one of the most flexible and durable of metals.

It can be bent or pounded into all sorts of shapes. It does not rust, and is therefore valuable in waterworks and their fixtures. It can be easily melted; and had we the right molds we could pour some lead into them and make toys of all kinds. You have heard of Hans Christian Andersen's story of the little tin soldier. I am pretty sure, however, that soldier was made of lead or had lead in him. Some of the verses of our nursery days remind us of one of the uses of lead.

“There was a little boy
And he had a little gun
And his bullets were made of lead, lead, lead.
He shot John Sprig
Through the middle of his wig
And knocked it off his head, head, head.”

Lead is still used for small shot and bullets. Our pioneer forefathers made their own bullets, melting the lead in iron pans over the open fires, and pouring it into molds, where it hardened to shape.

But where does lead come from?

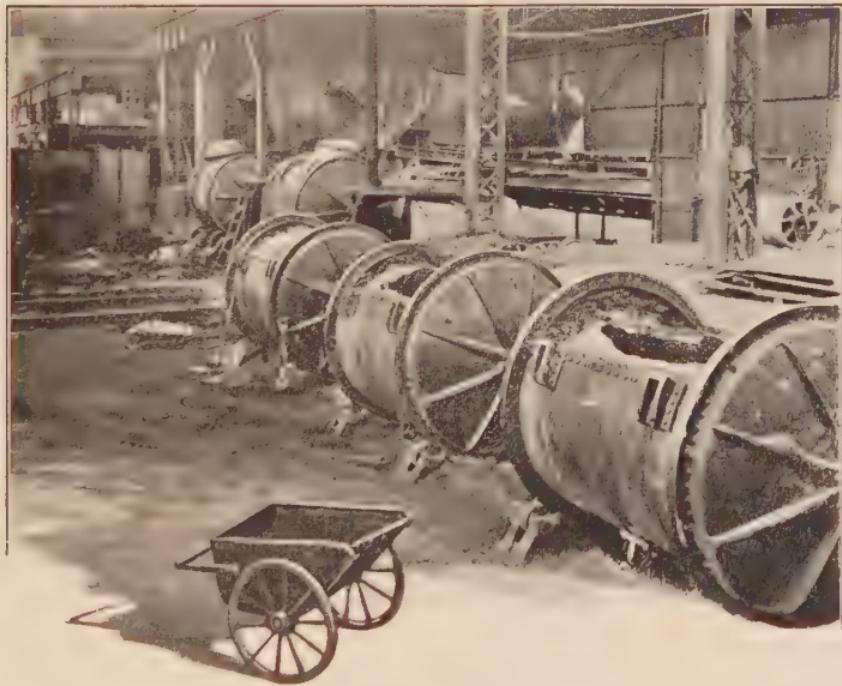
We find the ore in different parts of the United States, and it is common all over the world. For a long time the chief source of supply was Spain, and a great deal came also from Great Britain. When our country began to be settled, the first mines worked were in Virginia, Connecticut, and Massachusetts, and from them came some of the bullets we used in our wars with the Indians, and also with the British. As the pioneers made their way westward they found richer deposits of lead in the Mississippi basin, and especially in Iowa, Illinois, and Wisconsin. The city of Dubuque was named after a Frenchman who

bought lead mines near there from the Indians about 1780; and long before that, the Indians of Wisconsin, Illinois, and Iowa were smelting lead and selling the ore to the French traders. The Frenchmen wanted furs, and therefore they sold the Indians firearms and taught them how to handle the lead and make it into bullets. The Indians smelted the ore in rude furnaces made by digging holes in the hills, and they ran the metal off into leaden pigs which their squaws carried to the trading posts. After a time the ore became so valuable that it was used as money in the upper Mississippi basin, the rate of exchange being a peck of corn for a peck of ore.

Lead ore in its most common form usually contains more or less other metals. In this form it is known as galena. We have two towns in the United States named Galena, one in Illinois and another in Kansas, both so called from the lead deposits near by. We have towns farther west which were also named from mines of this metal about them. We have all heard of the city of Leadville, Colorado. It is situated almost two miles above the level of the sea, high up in the Rockies, and is built over veins and beds of silver and lead, while great mines producing these metals lie all about it. The lead of the Rockies is much mixed with silver, and in the smelting both metals are saved. In the mines about Joplin a great deal of zinc is mixed with the lead. Altogether we produce several hundred thousand tons of lead every year, the value of the product sometimes amounting to many millions of dollars.

Another metal largely employed as a building material is copper. Great structures are roofed with it, and the most beautiful doors of some of our public buildings have

been made of a combination of it and other metals. This is so of the huge bronze doors which form the entrance to our Capitol at Washington, and of those made by Ghiberti in the Baptistry at Florence. These doors have been cast to represent historical scenes, the figures of men and



In a copper smelter.

horses standing out upon them as though carved in the metal. The Crawford door which leads in from the portico of the United States Senate Chamber has panels representing the death of General Warren at the battle of Bunker Hill, George Washington on his way to his inauguration as President in 1789, and the laying of the corner stone of the Capitol in 1793. Inside the Capitol are bronze stairways; and the Library Building, not far away,

has a bronze fountain in front of it and bronze doors of remarkable beauty.

Copper is found in all articles made of brass, and we frequently have it in door knobs, and on the spigots and other fixtures connected with plumbing. We use it for the wires



In an Ohio brass foundry.

which run through our homes to the telephones, and also in those which carry the current for the electric lights. We have brass beds, copper and brass lamps, and, indeed, many beautiful things made of copper and brass.

In most of these articles the copper is mixed or alloyed with other metals. Sometimes the chief sister metal is zinc, and the two when melted together form brass. In other cases tin is combined with the copper, and in the past this alone was called bronze. Now an alloy of copper and

aluminiun is also called bronze, and the distinction between brass and bronze is not so sharply made as it was in the past. Both metals are now formed by mixtures of copper, zinc, tin, and aluminium, different proportions of the various metals being employed for making different things.

Copper is one of the oldest of metals. Indeed, some people think it was the first metal used by man. It lies in the earth in ores of different colors, being often mixed with rock and various metals. Red oxide of copper is reddish; malachite, which is carbonate of copper, is green; and copper pyrites is yellow.

We have vast quantities of copper. It is found here and there throughout the Appalachian Range. There are enormous deposits of it about Lake Superior in the northern peninsula of Michigan, and we have a great deal in Montana, Arizona and other parts of the Rocky Mountain Highlands where the ore is found in great masses. There are also large deposits in Alaska and California. Our annual product often amounts to hundreds of millions of pounds, and it is worth far more than our product of gold and silver.

Indeed, copper comes next to iron in the value of the metals we take from the earth. Our mines are so rich that they now yield the greater part of all the copper used in the world, although there are large deposits in Canada and Mexico, and in South America, Africa, Australasia, and Europe.

About the oldest copper mines known are those of the Spanish Peninsula. They have been worked since the time of the Romans, and thousands of miners are laboring in them to-day. The most famous are the Rio Tinto

mines, which lie about forty-six miles northwest of the city of Seville. They cover a space large enough to make fifty farms of one hundred acres each. The Rio Tinto ore lies near the surface, and it is dug and blasted out and carried on trains to the smelters. There are more than sixty miles of railroads in those mines, and thirty



Casting brass.

locomotives are kept busy taking out the ore. The copper is mixed with iron and sulphur, and it must be smelted in order to make the bricks or pigs which constitute the metal of commerce.

An interesting story is told of the discovery of the Calumet and Hecla Copper Mines of the Michigan Peninsula. They lie about five miles from the shores of Lake Superior, and are among the richest of their kind in the world.

Many millions of dollars' worth of ore has already been taken from them, and more is mined every year. The ore is largely in masses, some of which weigh many tons. Almost a half century ago no one knew that copper lay there, when one day a pig in wandering about through the woods happened to fall into a hole. He tried to root his way out, and thereby uncovered some of the ore and thus brought this great treasure vault to the eyes of man.

In making brass the copper is melted and the zinc gradually added, the two metals being so treated that they are thoroughly mixed, after which they can be run out into molds forming the castings desired.

Brass is soft, and can be easily bent. It is rolled in thin sheets, and drawn out into wire. If we would see how the rolling is done, we may do so by a flying journey to the great works of the Naugatuck valley in Connecticut. The Naugatuck River rises in the hills in the northwest-ern part of that state and flows rapidly down to the



Pouring brass into molds.

Housatonic, its mouth being at Derby. Between the towns of Derby and Torrington the fall is about six hundred feet, and this gives a great water power which is used by the brass makers. Most of the rolled brass of the United States is made there, and thousands of men are employed in the business. There are many large mills for melting and rolling the metal. They use copper and zinc, putting them together in the proper proportions for the material desired, and then running the product through rolling mills which turn them into plates of just the right size. They make sheets of all thicknesses down to some for eyelets, so carefully rolled that they do not vary more than half the breadth of a hair of your head.

Some brass has ninety parts of copper and ten parts of zinc. This is red brass, and has a copperish tinge. There are other combinations which contain sixty parts of copper and thirty of zinc. This brass is yellow, and looks somewhat like gold. Bell metal is more than three fourths copper, the balance being tin; and gun metal usually contains one hundred parts of copper to ten parts of tin.



22. A TRIP TO FAIRYLAND

WE shall enter fairyland during our travels to-day and make the acquaintance of the fairy queen, known as glass. She is one of the brightest, gayest, and most beautiful of the sprites engaged in house building, and one of the kindest to civilized man. She has driven the gloom and darkness out of our homes and allowed the sun and warmth to stream in. She is a truthful fairy. We

may peep into her face as it shines in our mirrors at any hour of the day; and she will tell us whether our hair is combed or untidy, whether our faces are dirty or clean, and even the state of our minds by the happiness or misery shown in the reflection. Queen Glass is also a worker in magic. Through her are created the most beautiful of objects, from the slipper which Cinderella lost during her dance with the prince, to the cut glass we use on our tables, and the glass beads and brooches which shine like diamonds when the light strikes them.

Some of the most wonderful things upon earth are not regarded by us because we have always had them about us. This is especially



Glass blower.

true of glass. When bits of glass are first shown to the savages of Africa they are considered as jewels, and glass beads are so precious that gold, ostrich feathers, and ivory are exchanged for them. I once traveled across the Korean Peninsula when that part of the world had been but little visited by white men. I had with me some mineral waters in glass bottles, and I found that the natives cared more for the bottles than for anything else I could give them. At that time the houses of

Korea had no glass, and their windows and doors were backed with oiled paper, which allowed but little light to come in. It was then the same in Japan, where the walls of the beautifully built homes are often a latticework over which a thin half-transparent paper is pasted. These move back and forth in grooves, serving as both walls and doors. The outer walls of the house are usually of boards, and are so made that they can be shoved back or taken away during the daytime, leaving the walls of lattice covered with paper to furnish the light.

The Chinese use paper for glass in many of their stores and houses, and both the Chinese and Japanese have lanterns of paper and horn. The horn lanterns are made by softening the horn and pressing it out so that it is almost transparent. In some of the old dwellings of the Philippine Islands shells are used for windowpanes, and it is said that the Romans had windows of horn.

Many of the castles of feudal Europe had only slits in the walls to admit the light, and even in the Middle Ages the houses of the common people were often lighted with panes of oiled paper. When our forefathers came to America glass was costly, and paper was often used in its place, the settlers bringing oiled paper with them for that purpose.

We must not think, however, that glass was not known before it came into use as a building material. Man had learned how to make it many centuries before that, and had used it for bottles, vessels, and beads for ages before he tried to put it into skylights, windows, and doors. There are pictures of glass bottles in some of the Egyptian tombs four thousand years old, and on the walls of

one of them is a painting of a man blowing glass. The ancient Greeks had glass vessels, and the Phoenicians made beads of colored glass and used them in trading.

But we have not yet learned what glass is. We shall find out all about it a little later on when we visit the factories. It will be enough here to say that it is made of silica, of which the sand of the seashore and other places is mostly composed, melted together with soda or potash and lime



Roman glass.

and oxide of lead, the character of the glass depending much on the materials used and their treatment. In short, we may say that glass is melted sand, for the proportion of other things in it is small.

The ancient Romans got their first glass from the Phoenicians, and they have left a story as to how the latter found that sand could be turned into glass. Pliny, a Roman writer, says that the discovery came from some Phoenician sailors whose vessel, containing a cargo of soda, was cast ashore on the coast of Palestine. The soda was in lumps, and when they built a fire on the sand they used them to raise their cooking pots above the coals. The

heat of the fire melted the soda and sand together and formed a rough glass.

It is doubtful, however, whether this was really the origin of the discovery. A heat so slight as a camp fire could hardly melt sand; and we know that the Egyptians

had made glass before that. The British Museum has a glass vase engraved with the name of an Assyrian king who lived long before the days of Daniel the prophet, and also a blue glass amulet which is almost as old as the Pyramids. Glass sheets, which were probably used for mirrors, were found in Pompeii, and the Emperor Nero, who reigned shortly after that city was destroyed, paid two hundred and fifty thousand dollars for two little glass vases.



Vase from Pompeii.

Among the most skillful of the early glassmakers were the people of Venice. They made mosaics, wonderful pictures composed of bits of colored

glass fitted together; and they floored and walled some of their cathedrals and other buildings with them. They also manufactured vessels and other things of glass, having processes the secrets of which it was death to tell a stranger. For a long time the glassworkers were not allowed to leave Venice, and if they did so men were sent after them with

instructions to kill them. One such glassworker, named Paoli, was tracked to France, where he was found one morning stabbed to the heart by a dagger on which was written the word "Traitor."

About the time that Columbus started out on the voyage during which he discovered America, the street of the glassworkers on the island of Murano, near Venice,



Venetian glass.

was a mile long and upon it were sold all sorts of beautiful wares which were made nowhere else. Among them were beads, bracelets, bottles, vessels, goblets, and mirrors backed with an amalgam of tin and quicksilver. The Venetians are said to have invented that kind of mirror. It is much the same as our mirrors of to-day.

Fine glass is still made by the Venetians, although the secrets of their work have long ago been scattered over the world. Some of them were carried to France by workmen who escaped, notwithstanding the danger, and

especially by a party of eighteen who went to Paris and established a glass factory there. That was just about one hundred years before George Washington was inaugurated as our first President. The Paris factory made mirrors by blowing the melted glass and bending it out into plates, which were silvered. Then a French workman discovered how to cast the molten glass, and for a hundred years France was the center of the cast plate-glass manufacture.

In the meantime the Germans and English had learned how to make glass of various kinds. The Bohemians had invented processes of making cast glass and cut glass, and had brought in the art of mirror making from the French. The English glassmakers were first taught by men imported from Venice and France, and one of them invented the process of making glass of lead flint, which was especially brilliant and hitherto unknown.

In our own country some glassmakers were brought over with Captain John Smith, but there is no record that they produced anything of value. A year after the Pilgrims landed at Plymouth some Italians were imported to make glass beads for the Indians, and a little later glassworks were built at New York, Salem, and Philadelphia.

Our first really successful glass factory, however, was started at Boston about A.D. 1787. Ten years after that time, the first one at Pittsburg was built, and now we have in different parts of the Union glass factories making all sorts of wares. The number all told is four or five hundred and their capital is many millions of dollars. Some of the factories produce window glass only, others make bottles, and others are devoted to cut glass and tableware. Penn-

sylvania has long held the first place as a glass manufacturing state. Indiana ranks next, and then come New Jersey, Ohio, Illinois, and New York.

23. A VISIT TO A GLASS FACTORY

WE each have a pair of magic spectacles this morning. They have been furnished by Madame Glass, our queen of the fairies; and through them we shall see some of the factories in which her wonders are made. We have come to Pittsburg by railroad and are now in an enormous establishment of many huge buildings filled with furnaces, tables, vats, and machinery of various kinds. Overhead is a network of pipes, rods, and belts, and below in the floor are great pits in which men are blowing glass somewhat as a child blows soap bubbles. They stand on the edges and swing long cylinders of red-hot glass back and forth.

How hot it is! The buildings have great openings to let in the air and huge machines are employed to keep it in motion. Nevertheless some of the men are bare to the waist, and we feel as though we should like to take off our flesh and walk about in our bones. The temperature required to melt the sand is about 3000° F. or nearly fifteen times that of boiling water, and this intense heat is kept up inside the melting tanks day after day while the glass making goes on.

We take a look at the furnaces. They are made to withstand the great heat; their walls and roofs are fire brick, and the walls are two feet or more thick and bound round with iron to keep them in place. The tanks or pots in

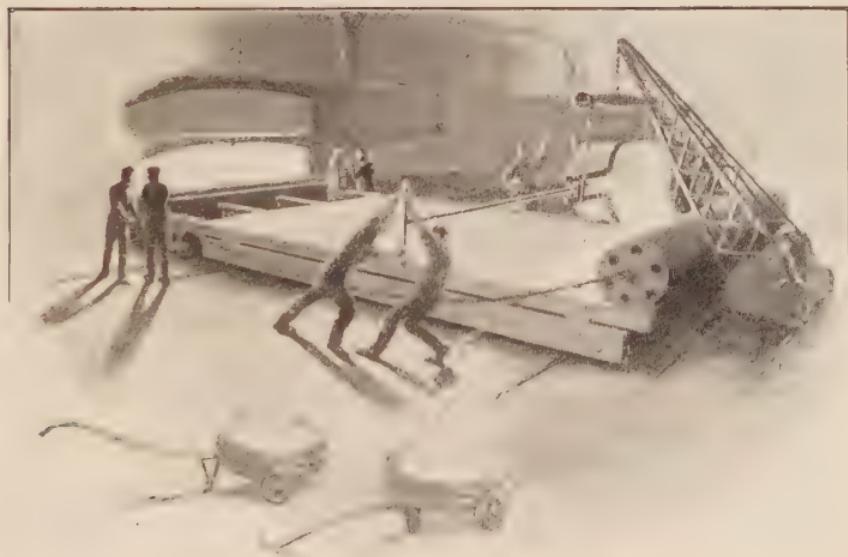
which the molten masses are fused are of the best of fire clay, and the tables upon which some kinds of glass are rolled into shape are cast iron.

But first let us look at the stuff which these men are about to put into the furnace. It is pure sand mixed with soda or potash and lime in just the right quantities. The mixing must be thoroughly done, and sometimes the mixture is ground to a powder before putting in. The sand must be good, and it is often purified by washing, roasting, and grinding. Much of that now used comes from Berkshire, Massachusetts; Juniata County, Pennsylvania; Hancock County, West Virginia; and certain places in Illinois and Missouri. The most extensive beds worked are those of Massachusetts and Pennsylvania. The lime is usually made of powdered limestone or chalk, and for fine glass the best marble dust is employed. In some glass, lead takes the place of the lime, in which cases red lead or a kind of yellow lead is employed. When the mixture is complete it is known as a batch, and is then ready for the pots or tank in which it is melted.

We first examine one of the tank furnaces, in which most of our common window glass is made. We watch the men as they shovel the batch into the great long deep tank of fire clay, mixing a little broken glass with it, that it may melt the more easily. The stuff goes in at one end and after melting flows out at the other. The heat is furnished by gas flames which pour over the mixture, the temperature being so high that the sand, soda, and lime are soon one molten mass which seethes and boils and bubbles under the flames.

As the mixing continues the impurities rise to the sur-

face and are so held back by floaters of fire brick that when the furnace is opened only the pure glass can pass out. From time to time new charges are put in, and the fire is kept going for months. The molten glass is usually allowed to stand for a while in order that its materials may be easily mixed and the glass be refined. During this time it is skimmed and samples are taken out and tested.

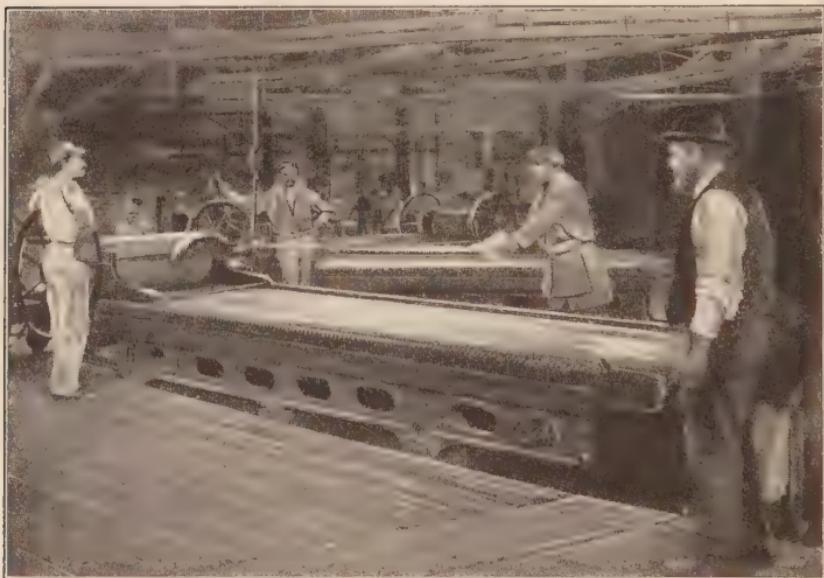


"We shall see plate glass made first."

It is next cooled, in which process it changes from a liquid state to a dough or paste, which can be blown into various shapes.

We shall see plate glass made first. We watch a pot of molten glass as it is taken from the furnace and lowered upon a truck. This is pushed through the room to a large iron table, where the pot is lifted by a crane and emptied. The hot glass comes forth much like taffy, ready for pulling. It is kept on the table by narrow

strips of metal which run around the edges. These strips determine the thickness of the sheets to be rolled. When the molten glass has been emptied, a heavy iron roller which travels on these strips is passed over the table, pressing the glass out and making it smooth and level. The table and roller must both be heated before the glass



Rolling plate glass.

is poured out in order that it may not be too rapidly cooled. The rolling must be carefully done.

As soon as the plate is rolled, it is taken to a second furnace, where it is annealed or tempered. This furnace has been raised to the same degree of heat as that of the glass upon leaving the rolling, and is so arranged that the plate will cool slowly during a number of days.

The plate is now ready for smoothing and polishing. As it comes from the annealing furnace it is rough, and

thicker in some places than in others. It must be ground down until it is smooth and even throughout. This is done by fastening it to a table over which cast-iron rollers are made to slide, while coarse sand and water are sprinkled upon them. The sand grinds the glass to the right thickness, and it is smoothed and polished by rollers covered with leather or felt and emery dust. After this it is further polished with rouge.

About one half the thickness of the plate is cut away during the grinding.

But suppose we go to those long furnaces on the other side of the works, where the half-naked men are making the common window glass we have in our houses. Each man stands before the furnace at a door which rests just above a long narrow pit in the floor. Now he opens the door, and we can see the red-hot mass of glass dough within. The man has a long iron pipe in his hand, with a mouthpiece at one end. He puts the pipe into the furnace, and dips it into the metal, as the hot soft glass is called. He twists it about and rolls the glass on it into a lump, just as one might do with rather stiff taffy. He keeps on twisting until his lump weighs about twenty pounds, when he lifts it out and holds it down in the pit. He now puts the other end of the pipe into his mouth and blows, whirling the pipe between the palms of his hands.



Making window glass.

As he does so the lump gradually assumes a pear shape. It is now laid upon a smooth slab of iron or marble and rolled over and over, and then put into the furnace again.

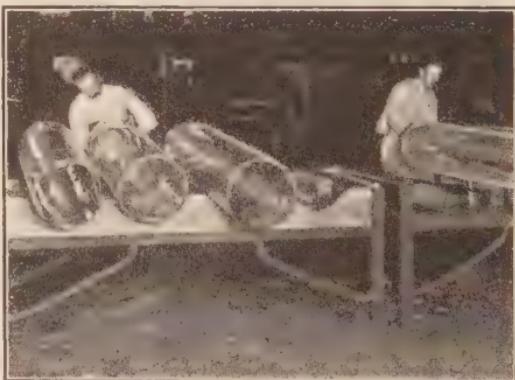


Reheating the cylinder.

A little later it is taken out, and again blown until at last the pear has become a beautiful cylinder of glass, closed at one end and attached to the blowpipe at the other. It is now as tall as we are, and a foot

or more in diameter. This cylinder has been made by blowing the glass, while swinging it to and fro at the end of the pipe in the pit.

But let us see what the man is doing with his cylinder. He has put it back into the furnace, and is heating it again. As he thrusts it in he closes the mouth of the blowpipe with his finger and the air within, which expands by the heat, bursts open the glass at the end. The cylinder is now taken out, and that part still hot is cut off with an iron tool. A thread of hot glass is next drawn around



Snapping off the ends.

the shoulder at the other end of the cylinder, next the blow-pipe, and a piece of cold iron passed around it. As the cold iron touches the hot glass the cylinder cracks and the mouth breaks off. It has left a round tube of hot glass which is even throughout and cut straight off at both ends.



In a South American glass factory.

A line is now drawn with a diamond from one end to the other on this cylinder, and the cylinder then laid in what is known as the flattening kiln. In a short time it opens along the cut made by the diamond, and under the influence of the heat flattens out so that it forms a smooth sheet of glass. This is window glass ready to be cut into the various sizes demanded.

Window glass is not polished before marketing, but it must be annealed or tempered. This is done in a long

oven, hot at one end and cool at the other, the glass being carried by a system of endless iron bands very slowly from the hot end to the cool one. Window glass is more easily broken than plate glass, and is less durable when exposed to wind pressure. The furnaces in which the batch

for sheet glass is melted are usually large. Some are from one hundred and fifty to two hundred feet long, thirty feet wide, and four or five feet deep. A factory can turn out a vast deal of glass in a year, the monthly output of one of the Pennsylvania establishments being enough to cover a space of twelve acres and leave some to spare.

Glass bottles and jars are generally blown, machinery being largely employed. The necks



Making cut glass.

of the bottles are first pressed and the body of the bottle, afterwards blown to the form desired in molds in which the raised letters, which are sometimes seen on the outside of such glassware, are carved. We make hundreds of millions of glass bottles a year; enough, it is said, supposing each bottle to be eight inches long and all to be placed end to end, to go three times around the world. We manufac-

ture also millions of lamp chimneys and tumblers, and a great deal of pressed glass. The latter is made in molds, which are hot at the time the glass is poured in. The pressed articles are afterwards heated almost to melting to give them a polish.

In cut glassware the pieces are first blown or pressed into shape, and the designs are then ground out by means of a wheel of soft steel or copper or sandstone, the cutting edge of the wheel being fed with water and sand or emery powder. The polishing is done on similar wheels made of wood, fed with rouge or putty powder.

Glass made of lead and sand instead of lime and sand is softer and more brilliant than other varieties and is used for cut glass.

Colored glass is formed by adding oxides or other forms of various metals to the batch, and mirrors are made by coating one side of the finished glass with silver. Mirrors were formerly coated with an amalgam of tin and mercury, but the silver mirror is now about the only kind made.

The window glass making we have seen has been done in tank furnaces, a great mass of glass being made at a time. In plate glass factories the materials are melted in great pots of fire clay, which are filled with the batch and then inserted in the furnace where the melting is done. In such melting it is important that the pots be raised to the temperature of the furnace before the batch is put in.

In making glass the character of the fuel is important. It must burn quickly and yield a long flame without much smoke or soot, and for this reason wood is often employed. For most kinds of glass, however, the

common fuel is coal; and natural gas, such as is found in Pennsylvania and Indiana, is greatly desired. When the gas fields there were at their best many factories were established near them, but the supply of gas has greatly diminished and crude petroleum and coal are now used in its stead.

24. PAPER—WOOD PULP

THE wonders man is actually working in this world of commerce and industry are far greater than the most fantastic dreams of the fairy tales. You may remember Aladdin's palace, which his genii built in a night. The palaces of steel which we drag forth from under the earth are quite as remarkable. The doings of electricity surpass those of the wonderful lamp; and, as for steam, it is more marvelous than the genii who rose in smoke from the bottles as described in the Arabian Nights. The Crystal Palace in London, which was made of real glass, would have astonished Sindbad the Sailor, even more than the diamonds in the valley from which he escaped by tying himself to the leg of the roc, that mighty bird as big as an elephant. How the whizzing automobile of to-day would have frightened the owner of the seven-league boots! And how quickly Bellerophon would have jumped from the flying horse Pegasus could he have had one of our modern airships in its stead!

Suppose we were walking about in a forest, and should meet the queen of the fairies, and ask her to perform some of her wonders. And suppose the fairy queen should reply: "I will turn these mighty trees into paper. That

giant poplar which now shades the ground, by a stroke of my wand I shall make fly to the cities and spread itself over the inside walls of your houses in sheets as thin and as smooth as your finger nail. I shall next touch that green spruce beside it; and lo, it will divide itself into sheets making a roof for your home, after which, by another



Spruce logs.

command, that grove over there shall be changed into thousands of newspapers and books."

Did we not know that these things are actually done, we might think the fairy queen joking, and be amazed to see them performed. It is with such wonders that we are to deal in the next field of our travels.

Suppose we leave the United States for a short run through the poplar and spruce forest belts of British

America. These woods have a soft fibrous nature which especially fits them for making the pulp from which the most of our wall papers come. Spruce and poplar are not uncommon trees. We have vast areas of them, and they are scattered here and there through much of our woods. Europe has many such trees, and they are found in great



Canadian spruce ready for paper.

numbers in Russia and Finland, and on the Scandinavian Peninsula, in all of which regions thousands of men are kept busy felling the trees and grinding them up into paper.

The greatest wood pulp forests of all are in the Dominion of Canada. There is a wide belt which begins in the province of Quebec on the Atlantic Ocean, and extends westward through northern Ontario to beyond the Great

Lakes. Newfoundland has a vast deal of pulp wood, and in a single river basin in Quebec, enough trees are still standing to make more than one hundred million tons of such wood. Canada has more than twoscore mills which are always grinding the wood into pulp, and its output is several hundred thousand tons every year. It not only makes a great deal of pulp and paper for its own people, but it ships much across the boundary to us.

As to the United States, we use more wood pulp than any other part of the world. Nine tenths of all our paper comes from trees of one kind or other, and this not only from our own forests but from pulp wood imported from Canada. We have enormous mills in Maine and elsewhere devoted to the industry. Our output is many million pounds of paper a day, and more, it is said, than that of all the paper mills of the rest of the world put together. Of this about one fourth goes into newspapers, some daily journals needing so much that a single issue requires one hundred tons or enough to clear the spruce forest from six acres of land. We have a mill in Maine which eats up from fifteen to eighteen acres of good forest every twenty-four hours. The wood is spruce, and the logs annually consumed are so many that if they could be spliced end to end they would reach from the site of the mill in northern Maine to the forests of Russia, where they are cutting similar wood for the paper of Europe.

But suppose we visit the mills and see for ourselves how wood is turned into paper. There are several in Canada not far from our boundary, and one of the most important is situated at the falls of the Saint Marys River, through which the waters of Lake Superior take

their twenty-foot drop to the level of Lake Huron. In making wood pulp a high degree of power is required, and these mills are near the site of one of the chief water powers of our continent. They are really harnessed to Lake Superior, and are using part of a force equal to sixty thousand horses all pulling at once. The mills are on the



It is first sawed into blocks two feet in length.

Canadian side of the Falls and the power for them is transmitted through a canal into which the water rushes at the rate of fifty thousand gallons a second. It requires a large barrel to hold fifty gallons. One of that size full of water would weigh over four hundred pounds, or more than four of the fattest boys in our party. Now, if we can imagine the force that might be created by one thousand such barrels or four thousand boys dropping from the second story of a house to the ground every time the watch ticks, all day

and all night, and every day and every night the year through, we can appreciate something of the force of the water as it goes through this canal. A great deal of the power is used for other manufacturing works near by, but much is employed to run the pulp mills. The water falls upon turbine wheels, which turning, communicate the motion to the machines overhead.

We first ask to see the wood before it goes into the mills. It has been cut during the winter in the far-away forests, and hauled upon sleds to the streams or the railroads. It is floated or carried down to the lakes, and then brought in rafts to the mills. Here it is first cut by a circular saw into blocks, each about two feet in length, after which the bark is shaved off by machinery consisting of rapidly revolving blades which make a deafening noise as they cut their way through. After that the wood, now clean and white, is ready to be carried on the endless belts through the wide galvanized iron passageway which leads up to the mill. If you will imagine a round stick of kitchen stove wood ready for splitting, you may have about the size of each piece.

We watch the men throw the wood on the belt, and then go on to see it ground to a pulp. We enter a large room in which are many small mills of iron about eight feet in diameter, and not more than eight feet in height. Each has a grindstone within it, and this is so arranged, that as the sticks fall in they are forced against it so that the wood is rubbed off. The stones move about at the rate of two hundred revolutions a minute and grind the wood as though it were cheese. It drops down as dust into the water, and when it comes out it looks like chewed paper.

It is now wood pulp, and has only to be purified and felted before it is ready for the market. As we look the foreman opens one of the mills, and asks us to take up some of the pulp. We do so, and find it quite hot. He tells us that the water flows into the mill icy cold, but



Inside a pulp mill.

that the friction of the grinding is such that it soon boils and steams.

After the pulp comes from the mill it is forced through wire netting in order to strain it, and is then thrown back into a tank of clean water in which a cylinder covered with wire gauze is revolving. The water passes through the gauze, but the pulp sticks to the cylinder, which, turning, drops it upon an endless blanket where it forms a coat and is felted together. As it goes on it is dried and pressed,

and finally comes out in huge rolls ready for shipment all over the world to be made into newspapers or perhaps into the beautifully colored wall papers we have in our houses. Sometimes the pulp comes out as thick cardboard, intended to be reworked before it is made into paper. Sometimes it is in paper ready for printing, a single sheet of which is so thin that four thousand pressed together are only one foot in height.

In another part of the mill, wood pulp is made by a chemical process. In this there is no grinding whatever. After the bark is removed, the logs are cut into chips, and then put into an enormous steel tank or boiler, filled with sulphurous acid and steam. These eat into the wood and digest it as it were, much as our stomachs digest food. The temperature is about twice that of boiling water. The cooking goes on for eight or ten hours and it finally reduces the chips to a pulp, which is then ready for the manufacture of paper.

Another process consists in boiling the chips under pressure with a caustic soda and limewater. This produces a dark-colored pulp which is easily bleached. There is also a third process, by which the wood chips are boiled under pressure in sulphate of soda.

It is by such means that not only our wall papers, but also the greater part of our newspapers and books are dragged out of the trees of the forest. In Shakespeare's play "As You Like It," the Duke, while voicing the delights of solitude in the forest of Arden, says: —

“ And this our life, exempt from public haunt,
Finds tongues in trees, books in the running brooks,
Sermons in stones, and good in everything.”

It remained, however, for modern industry to make the trees really speak, and, by the water power of the running brook, to turn them into printed books, such as this we are reading.

25. THE STORY OF PAPER

TO-DAY we shall learn of papers made of other materials than wood pulp; and, going back to the beginning of things, we shall ask how man discovered that fibers could be matted together into the beautiful sheets and webs we use for writing, printing, and house decoration. We shall find that wood pulp is a modern invention, and that it is through it alone that we are able to produce beautiful papers cheaply. Indeed, the papers made by the ancients were so costly that they could be used only for writing; and in the Middle Ages the parchment upon which books were written was so hard to get that the works of learned scholars were sometimes soaked or rubbed off that the blank pages might be used for new composition.

As to the world's first paper makers, they were probably not men at all. They were hornets and other wasps which make their homes of wood pulp. Hornets chew the woody fibers and by the aid of their saliva make them into a pulp of which they build the large oval nests found in our woods. It is possible some of you may be able to get one for your house-building museum. I warn you, however, to be sure the nest has been vacated before you attempt to secure it; for the little paper makers can sting and they will sally forth as an army in defense of their homes. The color of the nest is light gray, and its outer

walls are layers of paper. Each nest has a hole or door at the bottom, and its interior is composed of floors filled with combs supported by columns with passages between. The cells of the combs are of the same shape as those of the honeybee, but the walls are of paper instead of wax. They are really hornets' apartment houses, and some single ones are so large that they have thousands of cells.

The first human paper makers were the Egyptians, those ancient people who lived in the Nile Valley ages ago, and to whom the world owes so much for the beginnings of its civilization. If we could cross the Atlantic Ocean on one of the steamers which go weekly from New York to the Strait of Gibraltar, and thence sail over the Medi-

teranean Sea to Alexandria, we might visit the spot where was the most famous library of ancient times. This was composed of scrolls of writings upon a paper known as papyrus. And if we could travel far up the Nile into the Sudan, we should find there vast swamps filled with papyrus reeds, similar to those from which that first paper was made.

I have seen much papyrus during my travels in that



A hornets' nest.

part of Africa. It is a tall slender reed which at the ground may be as thick as the arm of a man, and at the top, where it ends in a great tassel of green, no bigger around than the finger of your baby sister. Some of the stalks are taller than a boy upon horseback, often reaching a height of fifteen or more feet. Each reed has a skin, surrounding a pith through which long fibers run.



Papyrus reeds similar to those from which the first paper was made.

In making paper the ancient Egyptians took off the skin, and sliced the pith into long thin strips. They laid these strips side by side, and then placed other strips upon top at right angles to them. The two layers were then rolled and pressed; and by the natural gum or sap in the plant were cemented into a crude paper, which, when dried and rubbed smooth, could be used for writing.

After finishing, the paper was cut into long rectangular sheets, which were rolled up and tied with a string. The

ordinary sheet was about twelve inches long and eight inches wide, or of about the size of our foolscap paper of to-day.

In ancient times the papyrus plant is supposed to have grown in lower Egypt, and some believe that the cradle or ark in which little Moses lay in the bulrushes on the edge of the Nile was made of it. We know that it was used by the people of that time for making boats, boxes, and baskets, and that its fibers were woven into mattings and sails.

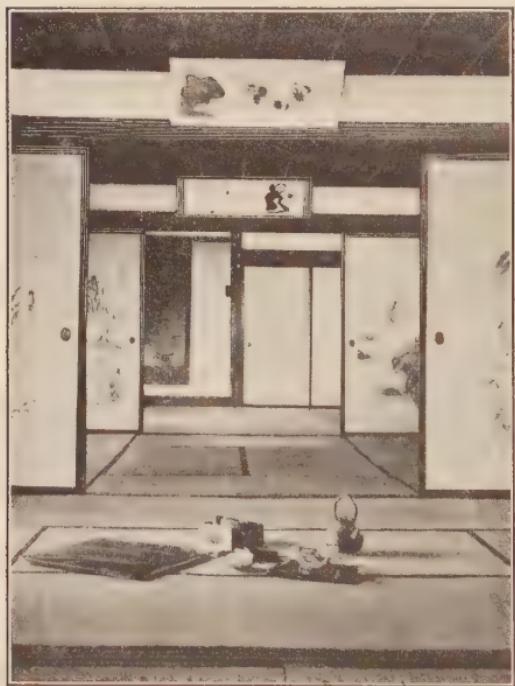
The first use of papyrus for writing was at an earlier date than 3500 B.C.; for a manuscript has been found which was made at that time. Others of the ancient papyrus writings have been taken from the old Egyptian tombs, and there are many such in the world's great museums, including that of Chicago, whose collection is especially fine.

Have you ever seen parchment? It is a tough paper made of sheepskin or goatskin. It is of the same material as a drumhead, but whiter and smoother. For many centuries it formed the chief writing paper of Europe, being employed for deeds and legal documents of all kinds. It was used for bookmaking, and a volume the size of this we are reading made of it would have required a large flock of sheep or goats to furnish the pages.

The invention of parchment, says Pliny the Roman, came from the rivalry of two ancient cities. These were Alexandria at the mouth of the Nile, and Pergamus, which lay across the Mediterranean in Asia Minor, about fifty miles from where Smyrna now stands. By the scale of miles we can locate the two towns on the map. Now the Alex-

andrians boasted of their magnificent library, and this made the people of Pergamus jealous and they planned to establish an even greater one in their city. Thereupon Attalus, the king of Pergamus, sent to Egypt for a great quantity of papyrus, and planned to hire numerous scholars who

should not only copy all the books known but write others as well. The Egyptians, however, who had a monopoly of the papyrus of the world, refused to sell to the people of Pergamus and they were therefore forced to secure something else as a writing material. In casting about for this they discovered the value of sheepskins and goatskins, and they prepared these so well that



Japanese interior. The rooms have movable screens of paper.

their wares became famous, the skins being known as *pergamena*, from which comes our word *parchment*.

It is doubtful, however, whether sheepskins were not used for writing long before that; for we know that men had written upon skins of various kinds prior to the founding of Pergamus. For instance, there was in one of the

ancient Egyptian libraries, so a historian says, a manuscript of snakes' skins upon which in letters of gold were written the works of Homer, the poet, who described the adventures of Ulysses, and told all about the flying horse Pegasus, the horrid Minotaur, and the wicked Circe, who changed men into hogs.

But however that may be, parchment continued to be used as a paper for many centuries after Pergamus was forgotten; and even now it is sometimes employed for college diplomas and important state papers. It is also used for costly book bindings.

In making parchment the skins are soaked in a lime pit until the hair can be taken off. They are next stretched upon a square wooden frame, and scraped with sharp instruments until they are perfectly smooth. They are then rubbed with pumice stone and chalk, until at last they are as smooth as glazed paper. By this process the skins are reduced to less than half their original thickness; they shine like ivory and are given a surface which will take the ink easily.

It is to the Chinese, that great people who invented the compass, gunpowder, and printing, that we are indebted for our first knowledge of paper made of wood pulp. Just when the Chinese discovered how to make such paper is not known; but they were manufacturing it from the mulberry tree while Europe was still using parchment. It is said that the Arabs, who conquered much of west Asia, discovered the secret during one of their campaigns, and that they introduced paper making into the towns and cities of Asia Minor. The Crusaders and others who visited that region brought the art into Europe.

Such paper was common in France before Columbus discovered America, and for a long time the French and Dutch were the chief paper makers of Europe. The Chinese papers had been made almost altogether from the inner bark of the paper mulberry tree, boiled and thus reduced to a pulp. After that the fibers were collected and felted on a framework or sieve of fine strips of bamboo. This was dipped into the pulp in such a way that when the water drained off the fibers were felted together. The sheets were then stripped from the sieve, and dried in the sun. After that they were smoothed and pressed out for use.

The people of Europe had but few mulberry trees, and they soon began to make paper of other materials. In Spain they used flax and then cotton, and after a time it was discovered that excellent paper could be made out of rags. Indeed, until within recent times the greater part of the paper of the world was made of worn-out clothing of cotton and linen.

The first paper used in America was of linen rags, and our first mill was established at Germantown, near Philadelphia, its product being only a few pounds of paper a day. In those times paper was scarce, and rags were in great demand. In a Boston newspaper, published in 1769, it is stated that "the bell cart will go through Boston before the end of the month to collect rags for the paper mills at Milton," and the editors requested that the women encourage the business by saving their rags. In 1776 Massachusetts made a law that certain men in each of its towns should be appointed to collect rags for the mills, and the people were asked to save them in order that the new

country might have the paper needed for printing, gun wadding, and other purposes.

After the Revolution, our paper mills increased rapidly. Machines were invented for beating the pulp and for weaving or felting it into a continuous sheet. The latter process was the Fourdrinier invention, an endless web of wire gauze, supported on horizontal rollers. This enabled the liquid pulp to be felted into an endless sheet of paper, and so treated that it came out polished and cut into sheets. The same machinery, somewhat improved, is used to-day. It is like that we saw in the mills making wood pulp. The pulp goes in at one end of the machine, and comes out at the other a finished paper, either in sheets or wound in the immense rolls which are used for our newspapers and books. Paper may be colored by adding dyes to the pulp; and the watermark in it is often produced by a slightly raised design on the wire gauze of the machine. This makes the paper a very little thinner along the lines of the pattern, and thus forms the watermark.

Some of our finest writing papers are made of rags, which we import not only from Europe but from Asia and elsewhere; so that the tinted notes upon which we send out invitations to parties may be composed of the cast-off clothing of savages. The rags come to the mills in huge bales and are thrown into the thresher, a round machine in which they are pounded and torn into bits, the dust being carried off through air tubes. After that they are sorted by women and girls, and the buttons, hooks, and eyes are removed.

The rags are then cut into pieces by machinery, when they are again whipped until all the dust and dirt have gone

out. The next process is boiling them, under steam pressure, in a mixed solution of lime, soda, and water. This makes the rags as white as snow, but they are still further washed, beaten, and cut, being finally reduced to a pulp from which the paper is made.

In addition to the papers we have seen, there are some made of straw, cornstalks, jute, rope ends, and other fibrous materials of various kinds. The English make an excellent



Loaded with esparto grass to be used for making paper.

printing paper of the esparto grass which grows in northern Africa along the edges of the Sahara, and is brought to the ports upon camels. The Japanese make paper of bamboo fibers and they have

various kinds of plants which they raise for this purpose.

The chief paper employed in building, however, comes from wood pulp. This is so not only of that which covers our walls, but of the thick, coarse sheets used for lining the inside framework of our houses and those coated with tar and other materials, which compose the various kinds of paper roofing everywhere sold.

Much of the wall paper is colored and printed in beautiful patterns, some of which are so raised that they look like stamped leather. This is done upon presses of various kinds, the paper running through one set of rollers after another, each roller printing one of the colors used in the

design. When the wall paper comes from the press, it has only to be dried and cut into the lengths required for the market. Other fine papers are printed by hand from blocks. In this process a separate block is engraved for each color, and the printer impresses the design upon the roll, handling the blocks so carefully that the finished pictures appear to have been printed. Gold and bronze papers are often made in this way, and velvety papers are produced by using the beautifully colored waste of the silk mills, the floss being cut fine and pressed into the design by the aid of an ink to which the silk sticks.

26. PAINTS, OILS, AND VARNISHES

WE must put on rough clothes for our travels to-day. We may as well roll up our sleeves and go as poorly clad as we can. Those who are especially dainty had better wear gloves, and the Miss Nancys among us might don aprons as well. We are to travel in the world of paints, oils, and varnishes, and some of our journeys may be not overclean.

We have already seen that these homes of ours, which we have taken so much as a matter of course, are really museums composed of wonderful things which have come from far-away places and through many different adventures. With the lumber we have traveled through the wilds of the forest, and with building stones and the metals have gone down under the earth into the quarries and mines. Like the Hebrew children we have passed through the fiery furnace in the manufacture of glass, and in our

study of paper have crossed the oceans to China and traveled from the papyrus swamps of the Nile to the woods of spruce and poplar along the Great Lakes.

The stories of paints, oils, and varnishes are likewise full of variety, and will necessitate our going to other parts of the world. The materials in them embrace the mineral and vegetable kingdoms; and, with the brushes used in laying them on, the animal kingdom as well.

Most of our paints are from pigments, which are mineral or organic bodies that can be ground up and mixed with oil, water, or spirits, in such a way that they can be spread over wood metal or other materials, giving them a color corresponding to the pigments used. The color of the pigment depends upon the amount and kind of light which it reflects; and, according to this, it may be of almost any hue or tint of the rainbow. The chief pigments are whites, blues, greens, yellows, reds, browns, and blacks, all of which have many divisions.

Pigments form the basis of our paints of various kinds, the paint consisting of the pigment mixed with some drying oil or spirits containing a gum or size. After painting, the oils or spirits evaporate or become dry, leaving the pigment which gives the color and with the gum or size preserves the material upon which the paint is spread.

Pigments come from so many different sources that we have not time to examine them all. There are some, however, which are more important than others, and the chief of these is white lead. That substance combines easily with linseed oil, and can thus be spread over wood, iron, and steel, giving them a tight coat which keeps out the sun and rain.

If you will go back in your mind to our travels in the mines, you may see where lead comes from and how difficult it is to take it out of the earth. At first thought one might say it would be impossible to secure enough of it to cover the houses of even one mighty city. And



Paint mixing and grinding room.

indeed, it would be so were the metal laid on in sheets or plates. It is different, however, with lead when used as paint. In this shape the houses of not only one city but of hundreds of cities are covered with lead. Each of our homes has more or less of it in one form or other. It coats both steel and wood, and guards them from the demons of rust and decay.

Of all the lead pigments, white lead is by far the most important. It was used by the Romans as a body for various paints, not only for buildings but even cosmetics. Indeed, the Roman ladies are said to have spread lead on their cheeks to improve their complexions. Later on white lead was made by the Dutch, and when our country was settled, a white lead industry began here. This increased rapidly as our lead mines were discovered, and we have now many factories for making lead paints. We have also some devoted to paints made of other pigments, and all together thousands of men are engaged in the paint-making industry.

In manufacturing white lead, sheets of the metal are thrown into vats containing an acid, or they are exposed to the vapor of an acid similar to vinegar. This corrodes the metal, forming acetate of lead. The acetate is ground fine and mixed with a small percentage of linseed oil, making the paint we know as white lead. It is put up in cans, kegs, buckets, and barrels to be sold. White lead is also made by other processes, but those in which acid is used have been known for hundreds of years and are still most largely employed.

Red lead is the oxide of lead. It is employed not only in painting, but also in glassmaking and in tightening or filling the joints of plumbing or piping. Litharge is a yellow lead oxide, made by melting the lead under a great heat in rapidly revolving cast-iron vessels.

In addition to these lead pigments we have many composed of various other metals and substances. There are blue pigments made of copper and cobalt, and also ultramarine, whose material is of about the same nature as the

beautiful stone known as lapis lazuli. Prussian blue is a compound containing iron, and indigo comes from the juice of a reed which grows abundantly in Java and India.

The green pigments come largely from copper, and the yellows are from lead and zinc and from certain kinds of iron and other metals. Some of the chief reds are from lead, mercury, and arsenic, while the browns are likewise largely from metals.

An odd pigment is the sepia, a brown which comes from the cuttlefish. That fish has a small bag or sac inside it where it secretes a brown, inklike fluid which it gives out when attacked or disturbed. The liquid discolors the water about it, and it can thus hide its movements. In preparing the pigment, the fish is caught, and the sac carefully removed and dried. It is next dissolved in caustic soda, and so treated with acid that it can be used for paint making.

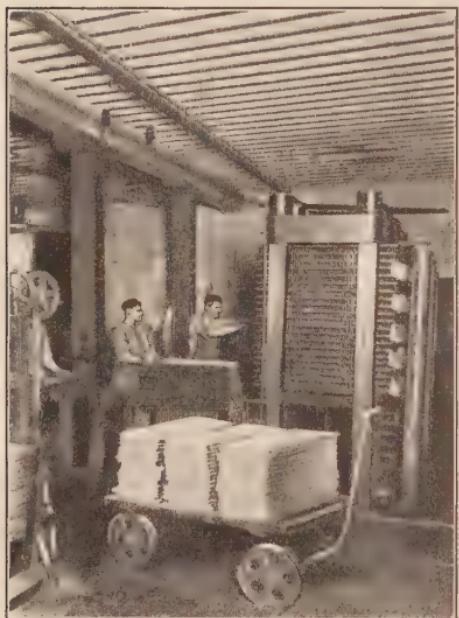
The black pigments are nearly all based upon carbon, the same substance found so largely in coal. The most important is lampblack, which is made of soot of various kinds such as that from the smoke of pine and hemlock or from that of petroleum or other mineral oils. In making lampblack the burning is carefully done, the soot being caught in a series of chambers through which the smoke goes. Bone black is made of burnt bone, ivory black of ivory, and some other blacks of charcoal ground fine. Blacks are also manufactured out of iron and copper, treated in various ways.

Is it not wonderful how man has called upon the genii of the mineral kingdom to give him metals to preserve and beautify the home he lives in? Yes, but we must re-

member that these genii have required other genii to aid them. They have worked in connection with their brothers of the vegetable kingdom who have furnished the turpentine, linseed oil, and other such things without which the pigments, however fine they might be ground, could not be used. Indeed, we are indebted for our paints to these

materials almost as much as to the pigments themselves.

Linseed oil is pressed from the seed of the flax plant, the fibers of which give us our linen. The seeds are cleaned and then ground into meal. After that they are steamed and then packed up in bags of pure camel's hair. While in the bags they are placed in huge presses which, exerting a force equal to two



Crushing flaxseed in presses.

tons per square inch, cause the oil in the seeds to flow out. It is then filtered and run off into tanks ready to be barreled for the painters.

Linseed oil is used in three different forms — raw, boiled, and refined. Raw oil is the oil as it comes from the press. Boiled oil is the raw oil cooked over a fire with certain chemicals added to increase its drying properties; and refined oil is so treated that it can be used for varnish in

connection with gums and other materials. Raw oil is largely used in paint grinding, and every year millions of gallons of it are spread over our homes in the form of mixed paints. In every hundred pounds of white lead there are a little more than seven gallons of oil, so that oil is used more or less upon every room we live in.

This oil, boiled or refined, is also employed in the manufacture of linoleum and oilcloth. The oiled suits worn by sailors and fishermen are soaked in it, and it is used in making patent leather shoes and in other kinds of dressed leathers. It forms a part of our carriage tops and is also employed in making oiled silk. Mixed with ink, it comes before our eyes daily as we read the newspapers, and it is likely that the print on this page has some linseed oil in it. The paint industry, however, consumes the greater part of the product, demanding so much that the oil manufacture employs millions of capital and consumes a vast deal of seed. The mills for making linseed oil are scattered here and there over the United States, the chief centers of its manufacture being at Buffalo, Chicago, Minneapolis, and New York.

But suppose we go to our great Southern forest and take a look at the long-leaved pine trees, from the sap of



Gathering pine sap for turpentine.

which comes turpentine, another material used largely in the mixing of varnish and paint. Turpentine will thin all kinds of paints, and it is an excellent drier and mixer. It is also employed in the making of varnish. In gathering the sap, the trunks of the trees are scarred with axes to a point several feet from the ground. Then a box or



Loading turpentine barrels.

hole is chopped out at the foot of the tree into which the sap runs and is caught; or tin troughs are fastened in below the scars and a clay jar placed below them. The latter method is recommended by our Government Forestry Bureau. It is by far the better, as it does not injure the tree, which is soon destroyed if the boxes are cut in it, year after year.

Every few days the men come along with scoops and take out the sap, which having been exposed to the air is almost as thick as molasses. They put the sap into

barrels and carry it to the turpentine distilleries, which are great sheds in the forest under which kettles are boiling. The kettles are closed at the top, and from them metallic pipes run out in a coil, over which cold water pours. Pine tree sap is composed of turpentine and resin. After it is



Making varnish.

thrown into the kettle, the boiling drives out the turpentine in the form of vapor, which rises and passes off into the pipes kept cool by the water. As the vapor strikes their cold surface it condenses and changes to a liquid which flows out at the other end of the coil in the pure white spirits of turpentine we use for painting. Some of the turpentine farms, as these pine woods are called, have thousands of trees, and many men are employed in gathering the sap.

There are other gums in addition to that of the long-leaved pine which are much used in the making of varnish. Copal is gathered from the trees of the island of Mozambique and other parts of Africa, being brought to the ports along the seacoast for sale. Kauri gum comes



Storage house for varnish.

from the northern part of New Zealand, being derived from a pine tree of that name. It is often found in the swamps, having oozed out of trees which died ages ago. It is found there in lumps, weighing from a few ounces to one hundred pounds each, and it brings such high prices that men go about through the swamps and thrust down into the earth with sharp iron rods to find where it lies.

Kauri gum looks like white resin and some of the lumps resemble the most beautiful amber, which is a fossil resin

largely mined on the Prussian shores of the Baltic Sea. Amber is sometimes used to make varnish, but it is so beautiful that it brings higher prices as beads, pendants, and jewelry of various kinds. The Romans thought that



The Kauri pine tree from the gum of which varnish is made.

a necklace of amber would ward off the witches and protect the wearer from poisons. It was much esteemed for ornaments and charms, and Pliny says that in those days, when men were bought and sold as slaves, a little image of amber would often bring a higher price than a live man, even though the latter were stout and in vigorous health.

27. BUILDING A HOME

WE have all read of the troubles Robinson Crusoe had in making his home on the desert island. He first used a cave, like the cave dwellers of early times; and afterwards, bit by bit, with the aid of his black man, Friday, he built up his house and made it quite comfortable. He had but few tools and was forced to all sorts of makeshifts to accomplish his ends.

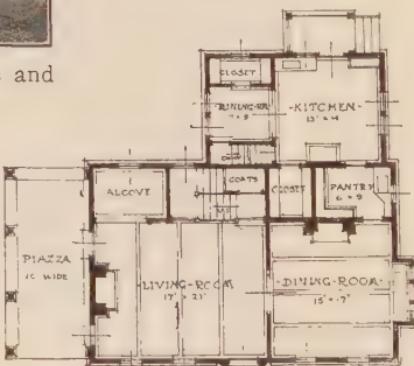
We shall now imagine ourselves to be a party of house builders. But



"We are ready to talk of the house and the plans."

not like Robinson Crusoe, for we shall perform the work of construction, not on a desert island, but surrounded by all the conveniences, finished materials, modern machinery, and skilled workmen of the most advanced people on earth. We shall not be able, like Aladdin of the Wonderful Lamp, to order a palace to-night and find it finished and furnished next morning, but we shall have all the advantages of modern civilization.

How shall we start in the making of our home? The first thing is the site or place where the house is to stand.



In the country or where land is comparatively cheap, we should select a large space with plenty of ground all around, or if in the city we might be confined to a lot so small that the house would cover it all. The first thing in each case would be to buy the ground, and to see that we had a clear title of ownership to it. This is important, for if we cannot prove that we own it, some one may raise the doubt and even after we have built force us to leave. Our parents can tell us how land is bought and sold, and how in the public offices records are kept of every tract which is transferred from one man to another. One form of the record of such a transfer is shown on the following page.

After having satisfied ourselves with the lot and its title, we are ready to talk of the house and the plans. It will not do to start building until we know just what we want. This can be shown by plans drawn to a scale and accompanied by written explanations or specifications of all the materials and how they are to be used. We may get these of an architect, whose business it is to make plans for houses. If we tell him our needs he will furnish a design of the kind of a dwelling that will supply them. He may charge us so much for the plans, or may say that for an additional sum he will also superintend the construction, and see that they are carried out. The architect's charge is sometimes a percentage on what the house costs. If the house is small, and we know pretty well what it should contain, we may make the plans ourselves, although this is not advisable unless we have had some experience in building.

After the plans and specifications are prepared, they may be let out to a builder who will contract to put up the

This Indenture,

made the fifteenth _____ day

of September _____ in the year nineteen hundred and five _____

Between Charles A. Drake, unmarried, of Geneva, Ontario County,

New York, party of the first part, and Edward Simmons, of
Rochester, Monroe County, New York, party of the second part.

Witnesseth, That the said party of the first part, in consideration of the sum of
two thousand (2,000) dollars, lawful money

of the United States, paid by the party of the second part, does hereby grant and release
unto the said party of the second part, _____ his _____ heirs and assigns for ever,

All that Tract or Parcel of land situate in the City of Rochester,
County of Monroe, and State of New York, and more particularly
distinguished as lot number twenty (20), as laid down on a map
of Snyder & Stone's subdivision of a part of the Strong Tract
on file in Monroe County Clerk's Office in Liber 5 of Maps at
page 83. Said lot number twenty (20) is situate on the east
side of Kenmore Street, and is thirty-three (33) feet in width,
front and rear, and one hundred and fifty-nine (159) feet deep
Together with the appurtenances and all the estate and rights of the party of the first
part in and to said premises.

To have and to hold the above granted premises unto the said party of the second part,
his heirs and assigns forever.

And the said Charles A. Drake, _____

party of the first part, does covenant with said party of the second part as follows;

First. That the said Charles A. Drake, _____

party of the first part, is seized of the said premises in fee simple and has good right to convey
the same.

Second. That the party of the second part shall quietly enjoy the said premises.

Third. That the said premises are free from incumbrances.

Fourth. That the party of the first part will execute or procure any further necessary
assurance of the title to said premises.

Fifth. That the said Charles A. Drake, _____
party of the first part, will forever warrant the title to said premises.

In witness whereof, the said party of the first part has hereunto set his
hand and seal the day and year first above written.

In presence of

B. T. Cox

Charles A. Drake

house at a fixed price or on a commission. If this is done, the builder will buy the materials, hire the workmen, and agree to deliver the house to us completed within a certain fixed time. He is under the superintendence of the architect, who sees that the plans are carried out in all of their details.

As to the construction of the house, this depends so much upon its location, character, size, and the materials of which it is built, that the description of any one dwelling will not give us a rule for all others. The building conditions differ greatly in city and country, and the house whose foundation is on the sand requires things not needed by that which stands on a rock. Houses of wood are not built like houses of brick or stone, and the great steel structure is unlike any other. Indeed, each of our dwellings is to a certain extent of its own kind, although it has many things which are common to all.



Building a skyscraper.

First every house must have its foundation, its walls, and its roof. The foundation must be firm and evenly fixed in the earth or the house may sink or lean like the great Tower at Pisa, and perhaps topple over. The foundation may be on firm ground or if the house must

stand where the earth is not firm, piles may be driven down to make a foundation. This is the case in Amsterdam, where Erasmus said the people lived like birds on the tree tops. In our own country, buildings in marshy or swampy places are often erected upon foundations of concrete and iron. This is so in parts of Chicago, where on the soft ground near the lakes, steel rails are laid down and filled in with cement, and other rails laid above crisscross or at right angles, similarly filled, until a great solid block is formed upon which the house rests. Even greater precautions are required for the heavy steel structures called skyscrapers, as we shall see later on.

And then the walls of our houses! They vary from those in our massive stone buildings, two feet or more in thickness, to the tall office structures, which often consist of a framework of steel with only a thin veneering of brick or stone to keep out the weather. We have walls of wood, stone, brick, and concrete, and even sheet iron.

It is the same with the roofs. They are of many materials, each made and put on in its own way. Thousands of our buildings are covered with shingles from Oregon and Washington, and other thousands are protected by tin or galvanized iron. We have roofs of boards, slate, and glass. We have some of terra cotta tiles, glazed like fine china; and roofs of paper covered with asphalt or pitch upon which have been sprinkled pebbles or sand. Indeed, the manufacture of roofing materials alone forms an important industry, employing and supporting a great many people.

But the foundation, walls, and the roof are merely the shells of our dwelling. They aid in keeping out the rain and sun, but alone they would not form a much better

home than that of the cave men. Indeed, we require so many things in addition that our houses are very beehives of invention. They must have floors and ceilings, windows and doors, stairways from story to story, and arrangements of various kinds for cooking, heating, and lighting, as well as for the water supply.

All these things should be provided for in the plans; and in the cities or towns each class of house building is done by men who will do little else. The foundations and brick or stone walls must be laid up by masons, the wood-work is put together by carpenters, and if the roofs are of metal, they will be laid on by tinners and roofers. The piping of the house for gas, heat, and water will be done by the plumbers; while if we have electricity in any form we shall need electricians to wire the structure in such a way that it may not take fire. And then the painting is to be done by another class of laborers, the lathing by another, the plastering by a third, and so on, each class having a place of its own. In the larger buildings the work is still further subdivided, until in the great office structure the laborers form a small army of many companies, each of which is skilled in one form of construction, and will do nothing else.

Indeed, the work of house building becomes more complicated from year to year. New inventions bring forth new materials and new tools. Stone is now planed and carved by machinery; wood moldings which were once laboriously cut out by hand are now made at the mills, ready to be fitted into the houses; and wire cloth sometimes takes the place of lath. We shall learn more about such features of building construction as we go on with our travels.



Erecting the 31st story of the Whitehall Building.

28. THE WORLD'S TALLEST BUILDINGS

SOME years ago a little black boy whose home was a thatched hut in the wilds of Africa was taken by a missionary to the city of New York. The voyage was made upon a steamer and the little fellow was interested in the mighty engines fed by coal which carried him over the oceans, and in the other strange things he saw upon shipboard. He was even more surprised at the wonders on land. He stayed for some months in America, and was then carried back to his people, who came together from far and near to hear what he had seen. The little fellow described the doings of steam and electricity. He told of the magic of the telephone, of the wagons without

horses which flew over tracks of steel, of the automobiles which ate oil and had a bad smelling breath, and of the electric light through which, by touching a button, man could turn night into day.

As he described these and other miracles, his black friends opened their eyes and mouths in amazement, half doubting whether what he said could be true. At last he began to tell of our houses and especially of the great structures of steel where a whole tribe of families dwelt in apartments one over the other, riding up and down to their homes in elevators which he called little cages of iron. He said that these buildings were so tall that the strongest and most skillful Bowman of Africa, standing upon the ground, could not shoot an arrow as high as their roofs. Upon that the whole crowd gave a shout and would hear nothing more. They talked the matter over together and concluded it could not be true and that the boy's stories must be lies from beginning to end.

We know, however, that the little fellow was well within bounds in such a description; and that we have many buildings so high that the strongest archer could not shoot over them. The home of the Metropolitan Life Insurance Company in New York is more than one hundred feet higher than the Washington Monument; other buildings there have forty or fifty stories, and some of those planned



Park Row Building.

for the future, will be taller still. The Whitehall Building in lower New York has a roof higher above the ground than the top of the Great Pyramid and it covers more

than a half acre. It has office accommodations for four thousand people, who are lifted to its thirty-one floors by twenty-nine elevators, eight of which are expresses that do not stop to let passengers off or on until the twentieth story is reached. The building is heated by the aid of twenty miles of steam pipes, and its machinery is more varied than that of many great factories.



A scaffold suspended in mid air.

The Park Row Building, opposite the New York Post Office, if we measure it from foundation to roof, although it is not so high by several hundred feet as some steel structures which have been erected since its completion, is almost as tall as the Washington Monument. It weighs forty million pounds, and is supported by four thousand piles, driven forty feet

down through the sand to bed rock. It has thirty-one stories, and in these there are nine hundred and fifty offices. It has seventeen hundred doors, two thousand windows, and seventy-five hundred electric lights.

But let us go to New York and take a look at some of these huge office structures. There are many which have long been completed and others are rapidly rising to accommodate the great population which increases each year. Such buildings are

required because those engaged in the many businesses of the metropolis can transact their affairs more

Singer Building.

rapidly if they can be close together. Therefore, as the space in the business centers is limited and the buildings cannot be spread out, they have arranged to have them go up. Some of the land in lower New York is now worth a million and more dollars an acre, and only buildings of immense height will make it possible to earn a rent which is in proportion to its

great cost. The more stories a building has the more offices and tenants it can accommodate, and the more



Times Building.



rent it will bring in. By the invention of steel construction it has been found that story can be added to story, with safety; and, by flying elevators, the people can ride up and down, so that the man who lives higher up than the top of the tallest fir tree of the Oregon woods is carried to his office more quickly than the pioneer could climb the rude ladders which led to the loft of his cabin.

The modern office building is often called "the skyscraper" because, as one stands on the ground beside it, its roof seems almost to scrape the sky. It has been described as a steel bridge upon end, with passenger cars running up and down within it. It is made of steel, like that used in bridge building, the beams, joists, and rafters being rolled into shape at the mills and bolted together with hot rivets. Every piece in the great structure must be exactly right before the work of erection begins, and the whole is put into shape like a gigantic puzzle, where each block has its place.

After the framework has been joined, the huge skeleton must have its steel bones covered with a coat of brick, tile, or other material. Then the plaster is spread on the metallic lathing, and the floors laid.

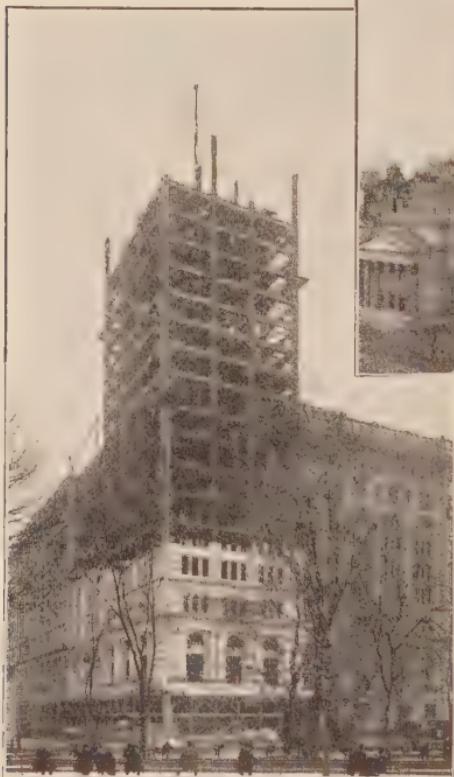
In the famous buildings of the past it was the walls which supported the floors and upheld the roof. In these steel structures, the walls serve merely as curtains to keep out the weather and are themselves supported by girders which project at the level of the floor. In the old buildings the walls were laid first. In the new ones the steel frame is erected and the walls are put on afterwards, the upper stories being sometimes walled in before the lower ones. During the construction the plumbing and wiring go on, and great furnaces, engines, and dynamos are installed in

the basement. I give on pages 244 and 245 pictures of the Metropolitan Building while in construction, and on page 246 one of Madison Square, showing the tower completed.

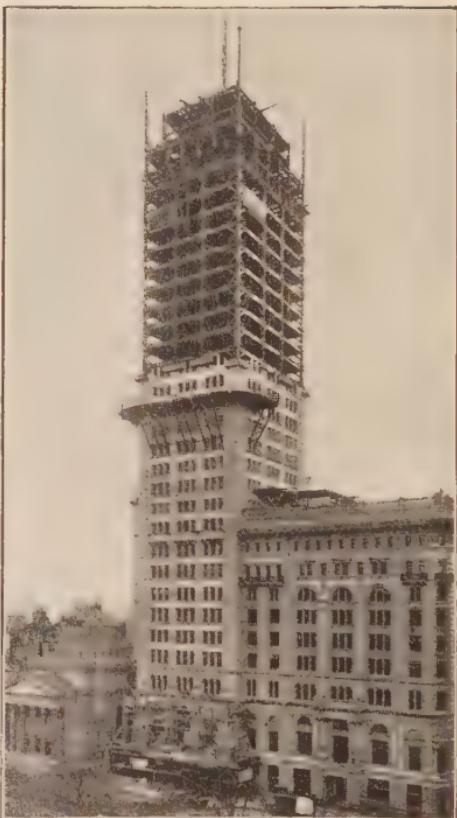
One of the most interesting features of the skyscraper is its foundation. The larger buildings are composed of steel, stone, and brick, and one may weigh thousands of tons. Indeed, a single building, with its contents, often weighs so much that, if it were taken apart and placed upon wagons, one hundred thousand horses all pulling at once could not haul the load. For such a structure, where the ground is not firm, an excavation must be made to bed rock, and concrete columns erected; or a great raft of steel rails laid crosswise and filled in with cement may form the base, in order that if it should sink the settlement will be even throughout. Under many of the New York buildings are hundreds of trees in the shape of piles which have been driven down into the sand for forty or more feet. These piles are in rows under those parts of the building which need most support. After they were driven far down into the earth, the sand was cleared away to a depth of a foot or so from the surface and concrete poured in, until it formed a great block of solid rock over the whole building site securely upheld by the trees. On this concrete base, huge blocks of stone were laid, and upon them were erected the brick piers capped with granite to which the steel framework of the structure was fastened.

The variety of things required in such building is so great we cannot mention all. A single large office structure reminds us of a little city under one roof. It may have its own gas and electric plants, and its own waterworks system fed perhaps by an artesian well

sunken hundreds of feet below its foundation. It sometimes has a restaurant on its top floor, and such conveniences in the way of stores, libraries, news stands, and telephone and telegraph connections in the various



November, 1907.
Metropolitan Building.



January, 1908.

stories, that one could supply all his needs from one year's end to another without going out. It often contains a bank and safety deposit vaults.

These buildings require a large force to take care of them.

Each has its superintendent with a host of employees, many of whom are in uniform. It has its engineers and electricians, its boys who run the elevators, and also messengers of one kind or other. It must have women to sweep and scrub, and men to clean the windows. The latter wear belts which are fastened by straps to hooks on the outside of the windows, so that if they should lose their footing on the sill, they might not fall from the great height to the ground.

The business of a large office building surpasses description. Its visitors are numbered by thousands, and so many go in and out in a day that it has been estimated that if they could be all collected and packed side by side like sardines in a box, the structure would be only just big enough to hold them.



July, 1908.
Metropolitan Building.

Of much the same nature are the apartment houses now to be found in all our large cities. In some of these scores of families dwell under one roof, being supplied by the heat, light, and water which come from the basement. Each family has an apartment or flat, consisting of several rooms connected together and all on the same floor. It will have its own kitchen, dining room, and parlor, with enough



Madison Square.

bedrooms to accommodate its members. The family use the elevator to reach their home, and the provisions are brought up on a dumb waiter or freight elevator. Heat and light are obtained by turning a valve or switch; and the gas stove of the kitchen has no ashes to be taken out. In many of the apartment houses are restaurants in which one may eat his meals or not as he chooses, and in some of them are playgrounds for the children, high up on the roof.

In addition to these large apartment houses there are

many small ones. Such are to be found in all the towns of the country, and I doubt not some of the boys and girls of our party may be able to tell us just how they are constructed and all about the life of these homes.

29. IN A NEW YORK HOTEL

THE hotel is the home of the traveler. It is there he eats and sleeps, there he receives his friends, and there he rests when not going about on business or pleasure. We have many families who live in hotels all the year round, and we have so many hotels that it takes several million people to run them. They are numbered by thousands, and billions of dollars are invested in them.

The American hotel is so arranged that it gives one most of the comforts he has at home. This is not so of the native hotels or inns of some other lands. In China, India, and northern Africa they are little more than sleeping places for men and beasts. When the Arab travels upon his camel, he carries much of his food with him and does his own cooking wherever he stops. Great caravansaries or stablelike inns are to be found in such cities as Damascus, Fez, Tunis, and Cairo. There the traveler sleeps on the straw, with his camel or donkey near by. In China the country inns are often one-story structures with windows of paper, built about courts in which the donkeys and horses are stabled at night. One is lulled to sleep by the crunching of the cattle as they chew their cuds, and he is often awakened by the donkeys which bray in concert from time to time during the night.



(248) "We now have some of the best hotels of the world."

The Japanese have neat hotels in both city and country; but at the native inns one must expect to sleep on the floor, and eat at low tables before which he kneels or sits cross-legged on cushions. He uses chopsticks; and the tea, rice, and other food will be brought to him on trays by little Japanese girls, who bump their heads on the floor in salutation as they come in to serve him.

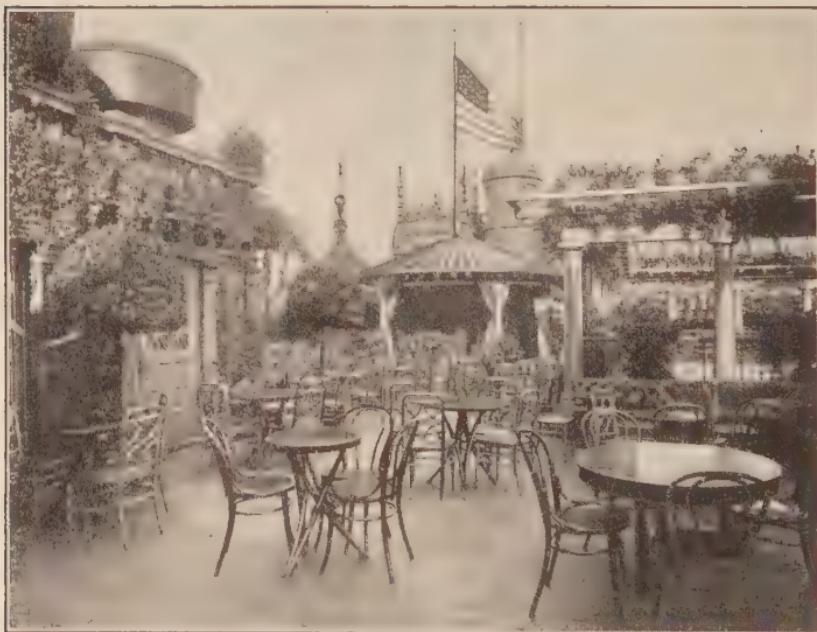
In a Turkish hotel the guests are often crowded into one or two rooms, many sleeping together. At dinner a roast sheep may be brought in whole; and the party may sit around this and each carve for himself. The Turks eat without forks and in taking up bits of meat from a stew they bend a piece of bread between thumb and finger and use it as pincers. Other nations of Asia and Africa have customs equally curious; and it is only the white race that has the modern hotel, with its separate room for each guest and its many conveniences.

The first hotels of our country were known as taverns or inns, and each had a swinging sign which bore some such name as "The Red Lion," "The Black Bear," "The Eagle," or perhaps "The Kings" or "The Queens." After the Revolution, some of the latter signs were changed to "The Washington," "The Franklin," or "The Lafayette" in honor of the great men of that day. When General Washington visited Boston he stayed at the "Bunch of Grapes" tavern; and at Trenton he lived at "The True American Inn."

As the United States grew in wealth and population, hotels began to spring up in the cities; and after railroads came increasing the travel they grew larger and finer, until we now have some of the best hotels of the world.

There are many such in New York, and it will pay us to visit them.

The one we select is known all over the country, and, indeed, we might say throughout the world. It has twenty-five stories above the ground and five stories below it, and the area of its floor space is such that if it were all on one level it would cover a good sized field. Its rooms are more than fifteen hundred in number, and when it is full, which is often the case, it contains, counting both servants and guests, more than three thousand people, its kitchens and



The roof garden where one can sit among the flowers and trees.

dining rooms being large enough to feed them all. This hotel has sufficient machinery in its basement to run a big factory. Its parlors are as beautifully furnished as the pal-

ace of a king ; and on its roof, which is far above the tallest church steeple, is a great garden where one can sit



"He leads us into the office."

among the flowers and trees and watch the fountain playing while he listens to the music of the band. The hotel has more than fifteen hundred servants, and of these about one hundred are boys who run errands, show the guests to their rooms, and carry messages of various kinds. Each boy receives twenty-five dollars a month for his work, and in addition has many tips or presents from the guests.

But let us suppose we have landed at the station and have ridden in a motor cab to the front entrance of this great establishment. Here we are met by the porter. He wears a gorgeous livery with brass buttons and has

a tall hat on his head. He takes care of our baggage and leads us into the office. This is a great room like a bank with a counter at the rear, behind which stand the clerks. The messenger boys conduct us to the counter, and a clerk gives us the visitor's book in which we write our names and the towns from which we come. He then assigns each a room, saying that he will put us all on the twelfth floor. Before going up we walk around to the post

office of the hotel and ask for our mail, stopping at the telegraph desk to send word home to our fathers and mothers that we have safely arrived in New York.

We next go up in one of the elevators and ask to be let off at the twelfth floor.



"Now we have entered our rooms."

Now we have entered our rooms. Each has a comfortable bed, a table or so, and some easy chairs. It has a bureau and wardrobe, and also a closet, inside which is a box which opens out into the hall. The boy tells us we can put our shoes there at night, and that they will be blackened by the time we awake in the morning. Connected with each room is a bath, with a large porcelain tub, and tiled walls and floor. The room has also a telephone, so that we can talk to people in New York and, by being switched on to the long distance lines, even chat with our friends at home. The telephone also connects us with the office of the hotel,

and if we want pens and paper, or ice water, or almost anything else, we can call up the office and ask that it be sent to our rooms. Every floor has its own employees, and it will not be long before our orders are filled.

We shall now go out and take a stroll through the hotel. The elevator carries us up to the roof, and we spend a while there in the garden. After that we go down from one floor to another, until at last we reach the one just over the office. This contains a great ballroom, an art gallery, and many beautiful parlors. It has the state banquet hall, a music room, and other gorgeous apartments.

Descending to the main floor we stop to look into the dining room and restaurants, where hundreds of men women and children are eating their meals. They sit about little tables and are waited upon by men in black clothes. We are shown the bill of fare. It contains almost every eatable under the sun, and it seems to us the whole world has been working to supply food for these tables. There is fruit from everywhere; melons from Canada, oranges from California, and bananas from the West Indies. There are apples from Missouri, peaches from Georgia, and grapes from New York. There are meats and game of all descriptions, and vegetables of the tropic and temperate zones. As we look the manager tells us that the hotel consumes sixty thousand dollars' worth of fish every year, and that its poultry alone costs twice as much. It uses about one hundred thousand dollars' worth of fruits and vegetables, twenty thousand dollars' worth of coffee, and eighteen thousand dollars' worth of flour. It annually spends eighty thousand dollars for butter and eggs, and a quarter of a million dollars for meats.

He asks us if we would not like to go down into the lower stories and see the supplies, and also visit the kitchens and other departments. We gladly accept his invitation and, entering the elevator and dropping five stories, find ourselves about fifty feet under ground. If the hotel were taken away, a four-story house could be dropped into the excavation, and with its ground floor where we are now its



In a hotel kitchen.

roof would not reach the sidewalk. Nevertheless it is as light as day. There are hundreds of electric lights blazing away. The floor is of white tiles, and the walls and ceilings are white. We are in the machinery department. Over there at one side are the furnaces which keep the rooms warm. There are a number of them, each connected with an enormous boiler. They consume a hundred tons of coal in a day, and more than thirty-five thousand tons every year. They supply, not only the heat, but also the power

for the machinery and that which generates the electricity. They not only light and heat the hotel, but they cool it as well, for they run an ice-making factory where water is frozen in great blocks half as large as a library table. In this department there are many mechanics. There is a locksmith who makes keys for the rooms and keeps the clocks of the hotel in order. There are carpenters and cabinet makers, and electricians and engineers.

We have now again entered the elevator, and ascended two stories to look at the kitchens. They cover almost an acre, and this space is taken up by stoves, broilers, great coffee urns, and kettles as big around as a hogshead, steaming with soup. There is one kitchen range which is as long as a city lot and half as wide as a schoolroom. Upon it food of all kinds is cooking away.

Here at the right is a bakery. That man in the white cap is the baker, and he can bake four thousand loaves of bread in a day. As we come up, he opens the oven. Its floor is as big as that of a parlor, and is covered with biscuits and rolls being cooked to a turn.

A little farther on are the butchers, some of whom cut nothing but steaks and chops all day long, and others dress only poultry and game. In a hotel like this each man has his own kind of work. The cooks who roast meat pay no attention to vegetables, and those who make the ice cream do not bother with the pastry. The hotel often consumes three hundred gallons of ice cream in one day, and it keeps several men busy freezing and molding it into the odd shapes in which it is served. The cooks are dressed in white with white caps. They are well paid and their chief has a big salary.

Leaving the kitchens we cross to the other side of the basement where the dishes are being washed. This is done by machinery. The plates, knives, forks, and spoons are put in wire baskets and dropped into a vat of boiling soap-suds, from which they come out clean and ready to dry. The drying is done by the heat which the plates get while in the water. This is so great that the moisture evaporates as soon as they are exposed to the air.

We are now tired with our trip through the basement, and we go back to the dining room. The waiter hands us the bill of fare and we begin to select the dishes we want, but are amazed at the prices. This is an expensive hotel, and one order of almost any sort of meat costs a dollar. We are therefore careful as to what we select. The portions are large, however, and as each is enough for several of our party we divide the orders among us and thus make out a good meal. When we have finished, the waiter hands us a bill on which is marked the price of each thing we have eaten, and we pay this before going out.

Moving about through the hotel we are more and more surprised at its wonders. It has a safe for valuables, a bank at which one can have his checks cashed, barber shops for both men and women, and a photograph gallery. It has a news stand and a drug store, and places where they sell candy and flowers.

In addition to the great hotels like this, there are thousands of smaller ones, including commercial hotels and those devoted to families. Every village has its home for the traveler, and there are hotels at the seashore, in the mountains, and at our winter resorts. Some of these are in use for only a few months of the year.

30. FIRE

TO-DAY we are again on the wing. We have taken an airship and are sailing about over the earth, stopping now and then at the homes of some of our little brothers and sisters on other parts of the globe. We want to learn how the world's houses are warmed and the many ways man has for cooking his food. To do this we shall first examine the heating arrangements of some far-away lands whose homes have less comforts and conveniences than ours. After that we shall look at the fires of colonial days, used by our ancestors when they were chopping their rude homes out of the woods, and then shall study our methods of heating to-day.

But first let us ask what fire is, and how man learned to make it. These questions are hard ones to answer. The ancients believed fire to be one of the four elements of which, as they thought, all things were composed. These were earth, air, fire, and water. We now know that earth, air, and water are each made up of other elements or things, and that fire is the visible heat or light which comes from certain bodies in the process of combustion or burning.

The ancient Greeks believed that fire came down from Heaven. Certain tribes of the Pacific Islands have a tradition that it was brought up from the lower regions where the great god, Maui, learned the secret of making it by rubbing two sticks together. Among the natives of the Tonga Islands the god of the earthquake is also the god of fire; and some of our Indians had a story that the first fire came to man from the buffaloes, which in gallop-



A Filipino feast.



ing over the prairies set them ablaze by the sparks from their hoofs striking the rocks. The ancient Grecian tradition is that Prometheus, one of the gods, stole fire from Heaven, brought it to earth in a hollow reed, and gave it to man. This made Jupiter, the chief of the gods, very angry and he condemned Prometheus to be chained to a rock on Mount Caucasus, where an eagle ate at his liver, which grew as fast as it was consumed and thus made his torment perpetual. The Greeks greatly honored Prometheus. They had a temple in Athens where he was worshiped, and in celebration of his present of fire an annual festival was held, one of the features of which was a torch race from his altar to the city.

The Scandinavian god, Thor, held a mallet in one hand and a flint in the other and with them made fire; while the ancient Peruvians believed that thunder and lightning came from one of their gods hurling stones with a sling. The Greeks called lightning flashes the thunderbolts of Jove, but the Peruvians thought they were the children of their god.

But however fire first came to be known—whether it was from a volcano which overflowed and in blazing streams of molten lava ignited the forest, or whether from the lightning striking the dry grass or trees—man soon learned its great value and was able to produce it himself. There are many savage tribes in Africa who start their fires by rapidly whirling one stick around in a hole inside another. In this the friction makes the wood hotter and hotter and by and by it bursts into a blaze. The Indians of this continent were making fire in much the same way when our forefathers came. They also used

pieces of flint, which they struck upon other flint and thus got sparks which they caught on dry punk. This is still



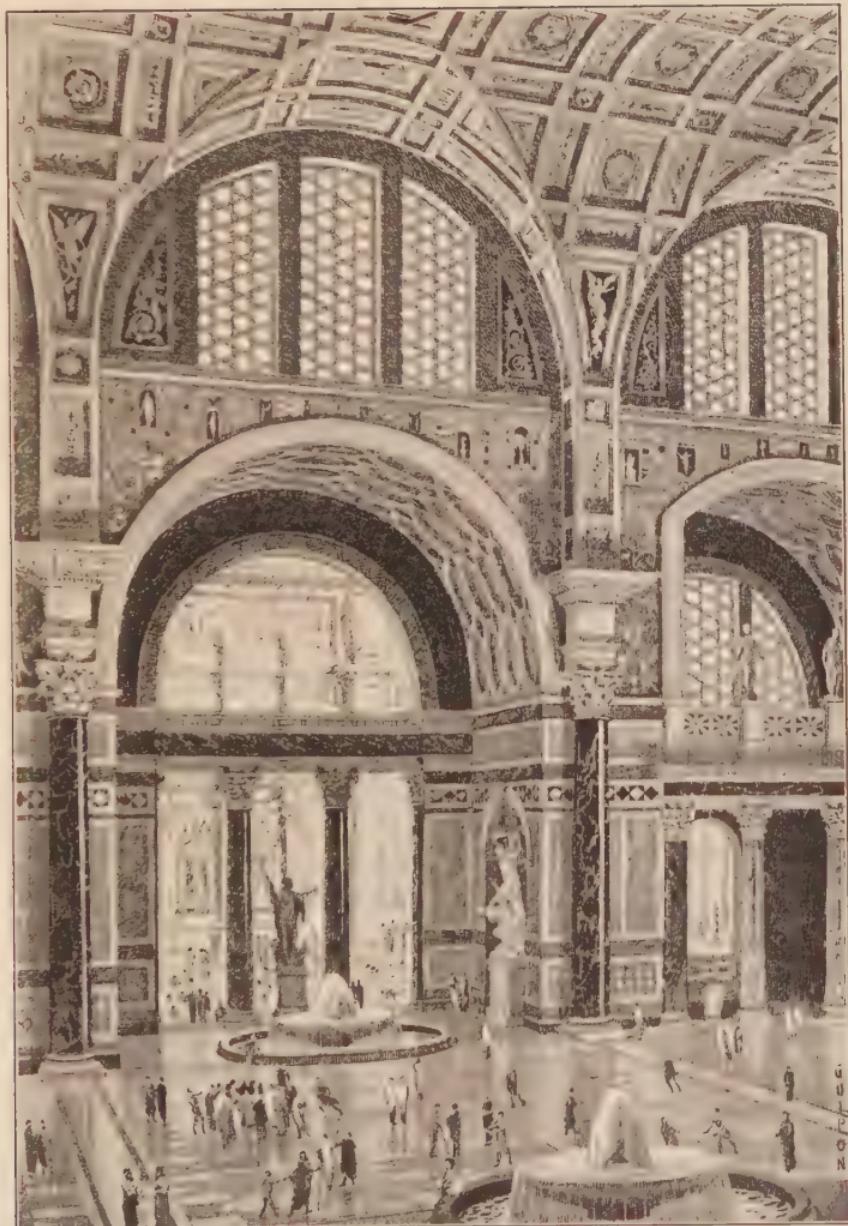
Making fire in Africa.

the custom among some of the tribes of Canada, the flints being an article of merchandise sold by the fur traders of the Hudson Bay Company. Our pioneer forefathers employed flints to kindle their fires and to light the powder

of their guns, and it is only of late years that man has had matches or percussion caps. As to the burning glass, that was known to the Greeks—as we learn from the story of how Archimedes set fire to the ships of the enemy at Syracuse by using a mirror. Moreover, the Chinese are said to have used such glasses ages ago.

Some nations have made fire an object of worship. The Persians did this, and also the Parsees, who are descended from them. The Parsees, who now live in India, have temples at Bombay in which are fires that are said to have been burning for hundreds of years. The Egyptians kept fires in their temples, as did the Romans in their Temple of Vesta, a goddess who was represented by the holy flame.

To-day fire is even more important to man than when he made it an object of worship. It not only lights and heats our houses, but, through the inventions connected with steam and electricity, moves the cars over the railroads and the steamships over the oceans. It forces the automobile to its speed of a mile or more a minute, and in flying machines enables us to go as swiftly as a bird



Roman baths (restoration).

through the air. It gives us all kinds of manufactures. It is the father of iron and steel, and, in some way or other, is the most necessary servant of civilized man as to all that he eats, drinks, and wears, as well as to his various comforts and doings all the day through.

Chemists tell us that fire is the rapid union of oxygen with other substances. When the union is gradual, we usually call it oxidation. Iron and oxygen unite and form iron rust, while hydrogen and oxygen unite and form the commonest of all substances, water.

In this book, however, we are chiefly concerned with fire as it relates to warming and lighting man's houses, and this alone is the object of our journey to-day. Our airship is ready to start. We get in and are soon high up in the clouds, flying at great speed towards the north. We shall visit the coldest lands first, warming our chilled blood at the fires of our Eskimo cousins. The winds aid the speed of our vessel. They shriek and whistle as they blow through its rigging, and the earth below seems to be moving fast towards the south. Now we have crossed our northern boundary and are passing over British America. We are almost on the shores of the Arctic Ocean, when we drop down among a score of what at first seem small mounds of snow, but are really igloos or Eskimo homes. Each is a little domelike building made of blocks of ice so fitted together that it has the shape of half an egg-shell. Over the ice, snow has been spread, and the only entrance is by a hole in the ground. We leave the flying machine and crawl in, pulling our coats tight about our necks in order that the snow from over the doorway may not drop down our backs.

Now we are inside. The house is so low we can hardly stand upright. Only a moment ago Jack Frost seemed everywhere. He pinched our cheeks, bit our noses, and we had to rub our ears to keep them from freezing. Inside the igloo it is so warm that some of our Eskimo friends have almost no clothing. The heat comes from that lamp of fish oil which stands at one side of the room. See, the flame is melting the roof; its heat has cut its way between the ice blocks and made little chimneys, as it were, which, with the draft from the doorway, give the house a certain amount of fresh air. Oil is used here for fuel, and in this small dwelling a very little is enough to keep out the cold.

We tarry awhile with our Eskimo friends and then fly on to the westward and drop down in Korea. Here the houses are largely composed of mud and stones, thatched with straw. We enter one, and are asked to take a seat on the floor. We do so, crossing our legs in Korean style. It was cold without, but it is warm and pleasant within, and we look about for the stove. There is none to be seen. After a time we grow uncomfortably warm, and, placing our hands on the floor, find it quite hot. It is covered with oiled paper stretched as tight as a drumhead, and it almost blisters our fingers. Upon our asking from whence the heat comes, the Koreans tell us that they have a network of flues under the floor, so made that when the fire is built in the kitchen the flames pass through them and heat the whole building. As we go out into the street we observe the smoke pouring from a clay pipe which is fitted into the wall of the house at about the height of our waists from the ground. More smoke is coming from similar

pipes in the other houses near by. There is so much that it has turned the air blue. The village is cooking its supper, and at the same time warming up for the night.

Crossing the Yellow Sea we travel among our slant-eyed little friends of northern China. Here the houses are heated in much the same way as in Korea, save that



"These stove ledges are the resting places of the family."

the flues pass under the kang, a ledge about as high as a chair which fills one half of each room. These stove ledges are the sleeping and resting places of the family. They are heated chiefly by the fires used for cooking. In the larger houses there are similar arrangements which may be used for heating alone.

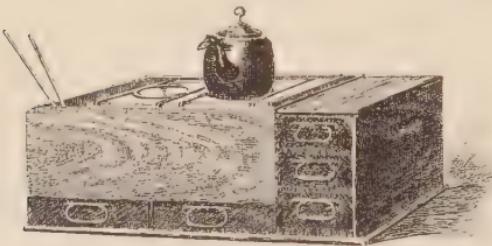
With many of the Chinese, however, the cost of fuel is

so great that they use only the surplus heat from the kitchen, relying upon clothing to keep themselves warm. Here in the north we see some who are dressed in furs, or in sheepskins with the wool turned inward. Farther south the people wear wadded cotton, putting on additional suits as the winter comes on. As the thermometer approaches zero they seem to fatten, and those who are naturally fleshy then grow so big, through their abundance of clothes, that it is almost impossible for them to pass through the doors of their homes. The little boys are so padded that they look more like balls than anything else, and should they fall down on the side of a hill, the chances are that snowball-like they would roll over and over, clear to the bottom.

We find the weather milder in Japan than it was in northern China, and the houses less tightly built. The thin walls slide in and out, and the air blows through the cracks. The buildings are made of wood and paper which quickly take fire, and hence kangs and flues are not safe. Most of the houses are poorly warmed by little fires of charcoal built in brass-bound boxes called hibachis, partly filled with ashes or earth. As winter comes on the people add more and more clothing, warming their feet and hands over these coals. There are no stoves to speak of, and only the palaces and large public buildings have heating plants. As we stand upon the hills to take a bird's-eye view of a city we look in vain for the chimneys, so common to every American town. There are but few such in Japan, most of the cooking being done in square boxes of charcoal, at one end of which is a copper-lined fire hole. It is also done on little clay stoves. The water for

bathing is heated by a charcoal fire built in a funnel-shaped stove in the back end of each bathtub. The stove has a pipe which passes up through the water, and makes

it so hot that when we get into the tub we quickly jump out. Our skins are now as red as a lobster, fresh boiled. Every Japanese house has its bath-



Japanese hibachi.

tub, and the larger ones have bathrooms. In all of the cities there are public bathhouses, where hundreds of men, women, and children take a hot plunge every day.

Our next stop is at the Philippine Islands. Here the cities have some large houses with stoves such as we have at home; but out in the country and in the villages, where the people live in houses of bamboo cane thatched with palm trees, the cooking is done in little clay stoves, which often rest upon a platform covered with earth. Sometimes such platforms are built under a shed or lean-to, adjoining the house. We are now in the tropics, and no heat is needed on account of the weather.

How would you like to live in a land where Mother Earth does the cooking; where, year in and year out, the boys do not need to bring in wood or kindle the fires; and where there are no ashes to carry away? This is the condition among certain tribes of Maoris whom we shall visit at their homes in northern New Zealand. We face our airship towards the southeast, across the Equator, and are soon soaring above the great island of New Guinea. We

then move on in the same direction over the Pacific Ocean and finally come to New Zealand.

As we land we see steam coming out of the earth. There are great pools of boiling black mud here and there, and geysers are spurting showers of hot water and steam high into the air. We are in the hot springs region, not far south of Auckland, where in many places the steam is always pouring forth from the earth. The Maoris, who have built their log houses near by, cook their meals in the steam. They use wooden boxes open on top and having only a network of cords stretched over the bottom. They place their food on the net and cover it with a cloth. They now rest the box upon or in the steam hole, and the hot vapor cooks the food quite as well as that of our steam cookers at home. In this way the Maoris boil eggs and potatoes, and stew and boil meats; they even make puddings for their holiday feasts. Some of them are excellent cooks, and we delight in the meals we eat with them on the hillsides, taking the food hot from the box. In this same region are many warm springs, where one can have a delightful bath at any hour of the day without the trouble of heating the water.

Almost directly north of New Zealand are the Samoan Islands, where the weather is so warm that no heat is needed except for preparing the food. There and in others of the islands about the natives have no stoves, and they sometimes do their cooking by building fires in holes in the earth lined with stones. This makes the stones so hot that any food placed upon them is rapidly cooked. Such holes are also used as steam ovens. A whole pig may be roasted, or meats and vegetables placed there in

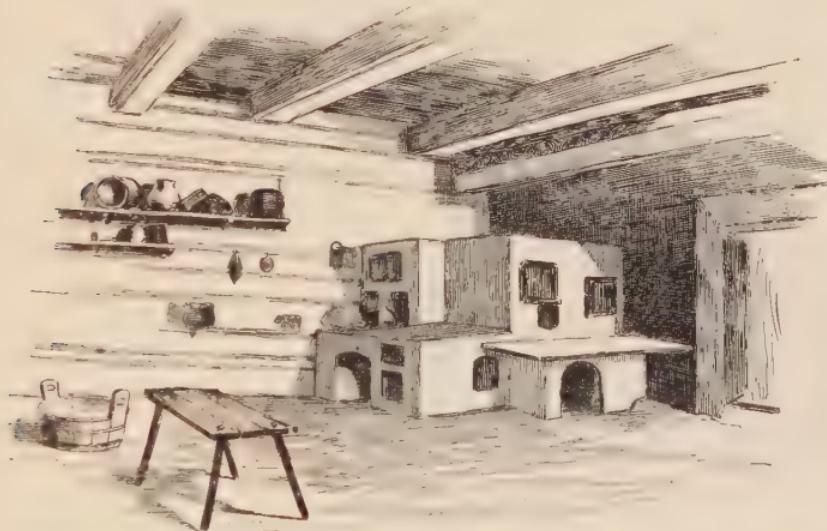
layers and covered with grass or green leaves. After that some earth is spread over the top and a little water poured in; or the steam from the leaves and the vegetables may suffice for the cooking. We taste some of the food prepared in this way. It is so delicious that we decide to make an oven ourselves the next time we go fishing or picnicking at home.

Leaving the South Seas we journey on to other parts of Asia and Africa, finding strange fire-making methods among the wild peoples. In Africa much of the cooking is done out of doors. In India, as we have seen, the chief fuel is the manure of cattle mixed with earth.

We now go to Europe, where fuel is more plentiful and the houses are warmed much like our own. We begin our travels in the great empire of Russia. This is a cold country, in parts of which it is winter for five or six months of the year. The houses are large, and those of the rich are heated with great stoves of porcelain built at one side or in a corner of each room. Every stove has many chambers inside it, and it is so easily heated that a comparatively small amount of fuel will keep warm a large room. On account of the severity of their winters, the Russians build thick walls for their houses, and fit them with double windows and doors.

The poorer people live in log huts thatched with straw. Their chief fuel is wood, and as in China the fires used for cooking serve also for warming the house. The stove of the peasant home is usually connected with a great chimney which takes up one side of the living room. Out of this chimney wall a ledge is made in such a way that the fire runs under it, keeping it warm. This ledge

usually forms the common sleeping place of the family, where the father and mother, brothers and sisters, grown-ups and children all sleep at night, as it were, on the top of the stove.



“The father and mother, brothers and sisters, grown-ups and children all sleep at night, as it were, on the top of the stove.”

One feature of every Russian village is the bathhouse, a large building or steam oven in which the people go for baths. They think it is desirable to perspire a great deal, and sometimes whip themselves with twigs to make the sweat come.

Crossing over to Germany, we travel through the various countries of North Europe, where the climate is much like our own. Here the people have stoves and grates, and the larger houses are often heated by steam or hot water. The German stoves are usually of brick and porcelain made like those of the Russians. They have also stoves of iron, cast into shapes similar to those of our country.

As we go southward the heating arrangements are poorer, and in the lands along the Mediterranean we find ourselves suffering more from the cold than in Sweden and Norway, where the weather is bitter cold a great part

of the winter. The reason is that the homes of southern Europe are by no means well heated. The summers are long, and even in winter it is comparatively warm in the sun, although chilly inside and quite cold at night.

We find, however, that the methods of



Piling up peat for fuel in Ireland.

heating of nearly every locality vary with the fuel near by. Europe has a great deal of coal, and this is especially so in England, where the houses are warmed much like our own. Germany and Ireland have vast beds of peat, a fuel which might be called unripe coal. It is usually found in low, swampy land. It is dug out and laid upon the firm ground to dry. It burns with a dull glow, and gives out a great heat.

Of the whole world, however, there is no country which has more or better fuel of all kinds than our own, and none which has so many inventions for warming its homes. As to these things we shall learn more in our travels to come.

31. WARMING OUR HOMES—FIREPLACES, STOVES, HOT WATER, AND STEAM

THE delightful fires of colonial days are well described by Whittier in his beautiful poem "Snow-bound," which I advise every one of our party to read. It pictures the home life of New England in the depths of mid-winter, when the whole family gathered around the great open fireplace and cracked nuts and ate the apples they roasted over the coals.

"Shut in from all the world without,
We sat the clean-winged hearth about,
Content to let the north wind roar
In baffled rage at pane and door,
While the red logs before us beat
The frost line back with tropic heat ;
And ever, when a louder blast
Shook beam and rafter as it passed,
The merrier up its roaring draught
The great throat of the chimney laughed."

This is followed by a picture of the scenes about the fire:—

"The house dog on his paws outspread
Laid to the fire his drowsy head ;
The cat's dark silhouette on the wall
A couchant tiger's seemed to fall ;
And, for the winter fireside meet,
Between the andirons' straddling feet,
The mug of cider simmered slow,
The apples sputtered in a row,
And, close at hand, the basket stood
With nuts from brown October's wood.
What matter how the night behaved ?
What matter how the north wind raved ?
Blow high, blow low, not all its snow
Could quench our hearth fire's ruddy glow."

In another place in the same poem, Whittier tells how the fire was laid:—

“ We piled, with care, our nightly stack
Of wood against the chimney back—
The oaken log, green, huge, and thick,
And on its top the stout back stick;
The knotty fore stick laid apart,
And filled between with curious art
The ragged brush; then, hovering near,
We watched the first red blaze appear,
Heard the sharp crackle, caught the gleam
On whitewashed wall and sagging beam,
Until the old, rude-furnished room
Burst, flowerlike, into rosy bloom.”

Such fireplaces were common in our colonial times. Then every family had more wood than it could use, and fuel cost comparatively nothing. To-day the great fireplace is to be found only in our forest regions, or on the farms where wood is still plentiful. In most localities, however, the colonial fireplace, so large that whole logs

were rolled into it, has disappeared and in its stead we have our boxlike stoves for wood, the base burners which eat anthracite coal, the petty grate, the hot air furnace, and the radiator or coil of pipes filled with

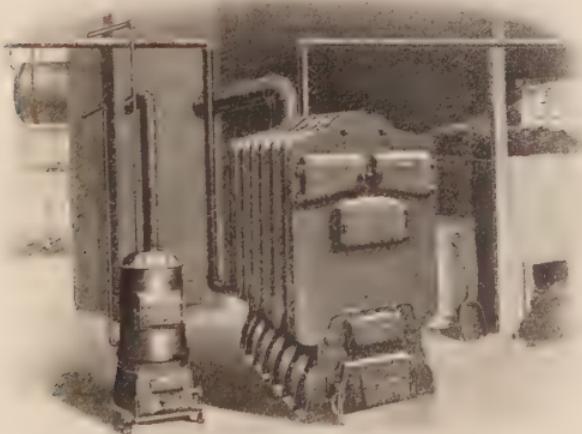


A Colonial fireplace.

steam or hot water from a boiler in the cellar below. These and other inventions have given us much better and

cheaper arrangements for warming our homes; but at the same time we long for the delights of the firepiaces of the past, and wish we could be back at the hearths of our forefathers roasting potatoes in the ashes or popping corn over the coals.

The change from the fireplace to the stove, the furnace, and the hot water plant has come, as far as the practical use of these things is concerned, within the past century.



Furnace room.

Stoves of cast iron were first made at about the time Columbus discovered America, but they were not in general use until centuries later. In 1744 Benjamin Franklin made an iron lining for a fireplace which threw the heat out into the room, and a little later he invented a box stove of cast iron for the burning of wood. Shortly after the beginning of the last century, stoves, with drums in the rooms overhead, were employed by the Pennsylvania Ger-

mans, and at an early time cast-iron boxes were built along one side of a fireplace so that the other end of the box projected into a room in the rear, thus heating that room.



Bedroom with radiator.

In those times churches were not heated, and each person had a little box stove which he took with him to keep his feet warm. These foot stoves were sheet-iron pans about six inches square in which live coals were placed. The pans were inclosed in casings of metal with holes in the top and bottom; and they had handles by

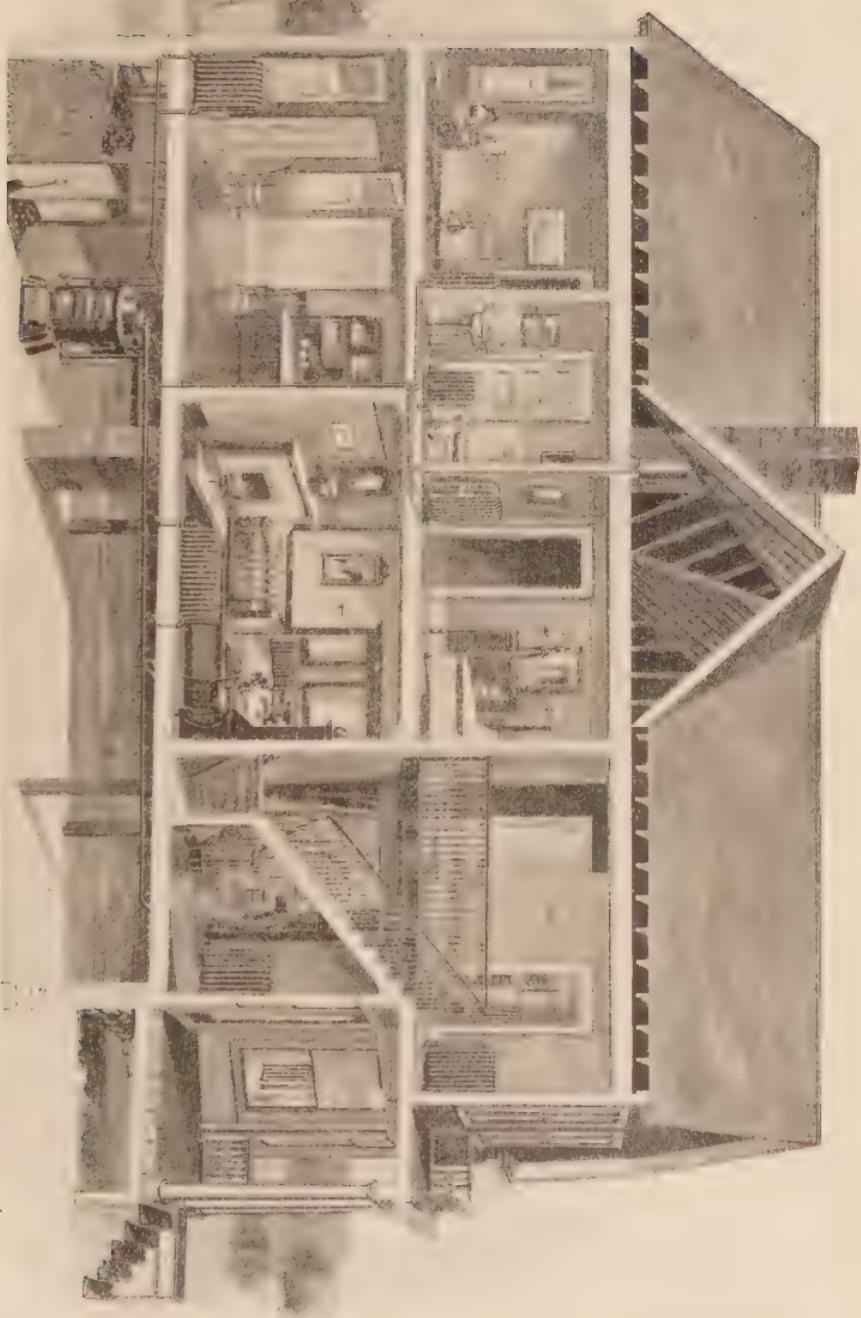


Diagram of house, showing heating system.

which they were carried. Stoves of sheet iron were made in Philadelphia along about 1800; and our first base burners were sold about thirty years later.

Our pioneer mothers cooked most of their food in pots and kettles hung by hooks or cranes over the coals of the fireplace. They baked their potatoes in the hot ashes, and sometimes had a brick oven built alongside the fireplace with an iron door leading into it. On baking day a wood fire was started inside the oven, and when it was thoroughly hot the coals were removed and bread placed on the brick floor. The first cooking stove probably came from making an oven in a box stove, after which the modern stove and range with the holes upon top and ovens at the sides or overhead were invented.

As to the furnaces which give us hot air, steam, and hot water, they are now more and more used. The hot air furnace consists of a compartment containing a fire and of iron walls so built about it and so closed in that the air which enters from outdoors through a flue passes between the fire compartment and the walls. It is thus warmed, and is then conducted to the various rooms of the buildings with which the furnace is connected by means of pipes or flues. The smoke is taken off through a pipe which connects with the fire only and is joined to the chimney. The heating pipes pass up inside the walls of the house, and the hot air is admitted to the various rooms through openings called registers.

It is strange that hot water should have been used for heating long before inventions were made for using hot air. Seneca tells us that the baths at Rome were heated from a coil of brass water pipes around which fires were

built; and we know that a Frenchman employed such heating for hatching chickens, and that an Englishman heated his conservatories in a similar way generations ago.

The first steam-heating plant used in America was brought over from England in 1842 by Joseph Nason, and it was several years later that Nason used small wrought-iron pipes about three quarters of an inch thick for warming buildings with steam. The first two steam-heating plants used in our country were in the Eastern Hotel of Boston, and in a woolen mill at Burlington, Vermont.

Since then many improvements have been made in house warming, and it is now possible to heat any kind of a building by steam or hot water. In such plants the fuel is consumed in a furnace in the basement, connected with which is a boiler for heating the water or making the steam. From the boiler iron pipes carrying the hot water or steam are run through the building. They are connected with radiators in each room, the amount of heat being determined by the size and number of the radiators. The heat may be regulated by the amount of fire under the boiler, and also by the valve which lets the water or steam into each radiator.

In some cases several houses may be heated from one central plant, the steam or hot water being conveyed from the boilers in the central station to the various buildings through underground pipes.

Among other methods of heating and cooking are those connected with gas and electricity. In most places these are too costly to be used for warming the house, although in and near the natural gas fields many villages and some

quite large towns are heated by pipes from the gas wells. The pipes are run through the houses, being connected with the stoves, grates, or fireplaces. When heat is needed it is only necessary to put a lighted taper near the openings of the pipes, and to turn the valve which admits the gas. After this it will burn until it is turned off, and at the end there are no ashes to be taken away.

In such fires the grates are often filled with slag, fire brick, or other materials which, being made hot by the flames, look like real coals. The imitation logs of clay or iron used in the fireplace seem to be blazing wood; while sometimes the gas plays over asbestos, making us think of sheets of gold leaf burning away. In many cities artificial gas from the public gas works is so used, and in most of the apartment houses the cooking is done on gas stoves.



32. LIGHTING THE HOUSE

BEFORE we examine the wonders of petroleum, gas, and electricity, let us take a look into the past and see how our forefathers lighted their houses. You may have read how Abraham Lincoln, when he was a boy of ten or twelve, read "Æsop's Fables," "Robinson Crusoe," and "Pilgrim's Progress" by the light of the pine knots in the fireplace of his log cabin home. The pine knot was one of the favorite lights of our colonial days. It was sometimes called the pine torch. It was found almost everywhere in the forest. It was burned on a flat stone placed in a corner of the fireplace in order that the dense smoke from it might go up the chimney.

In those times candles were almost universally used. They were made of beef tallow, and also of a wax from the berries of the bayberry bush. Nearly every family made its own candles, and all saved for this purpose the tallow from the beef which they ate. Making the candles for the winter was a special occasion which consumed one

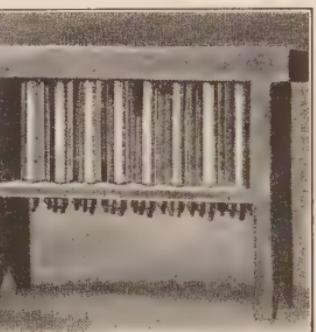


Candle dipping.

or two days every autumn. At that time the tallow was melted in a great kettle over a fire outside the house. Then two poles were supported on the backs of chairs and upon them the candle rods, small sticks about eighteen inches long to which wicks were attached, were placed. In making the candles the rod with its row of wicks was dipped into the kettle. The tallow stuck to the wicks. It

soon hardened, and by dipping again and again each of the wicks was surrounded by enough tallow to become a candle of the right size. This work was slow, about two hundred candles being all that one person could possibly make in a day. In other places the candles were made by running the tallow into molds consisting of groups

of tin or pewter pipes through which the wicks ran. There were candle makers who went from house to house carrying such molds, and making the candles for the family at so much per dozen or pound.



Candle molds.

Another light much used in colonial times came from the oil which was brought by the whalers of New England from the waters about Greenland and other cold seas. The whales they caught were frequently from sixty to one hundred feet long and some weighed as much as two hundred oxen. The oil came from the blubber or fat of the whale, of which there was a yellowish white mass under the skin ranging in thickness from eight to twenty inches. After harpooning the whale and killing it, the men cut off this blubber in large pieces and packed it away in the holds of the vessels and thus brought it home. The blubber was melted and skimmed, and the oil therefrom was burned in rude lamps of pewter and glass.

If we could take a rapid trip around the world, we might find many people still using lights like those our

forefathers had. In the wilds of Africa are tribes which rely upon burning wood or palm nuts for their light, and among the Eskimos fish oil is commonly used. There is said to be one fish in Alaska which contains so much oil that, when caught and killed, one may sink a wick into its back, and when lighted the fish will burn like a candle.

In China there is a certain tree called the candle tree, the wax from the leaves of which can be burned, and in Brazil grows a palm tree known as the carnauba, whose leaves furnish a wax which is made into candles and used to the extent of several million pounds every year. In some countries coconut oil is used for lighting, and in others olive oil is employed the same way.

Candles still form the chief light of many lands. They are used largely in Europe and Asia, and the United States has great establishments which are kept busy manufacturing them for our home market. There is a candle factory at Cincinnati which makes one hundred thousand a day; so many that if they were all molded into one candle of the usual thickness, it would be thirteen miles long.

It seems strange that man should have kept on for centuries using such lights as we have described, while all the time Nature was telling him that she had stored underground vast quantities of oil which would burn better and furnish more light than anything he had yet been able to make. Five hundred years before Christ, Herodotus wrote of oil wells on the Island of Zante; and during the Middle Ages, Marco Polo, a celebrated traveler, told how he saw oil from near the Caspian Sea carried on camels through Asia. At about the same time petroleum taken from the surface of a lake in Bohemia was being sold as a medi-

cine; and a legend is still current in the Russian oil territory that Alexander the Great while traveling through there killed a boy by drenching him with burning water. In our own country, the oil coming out on the surface of the earth had been set on fire long before the first oil well was dug; and natural gas was lighted many years before any one thought of bringing it into our homes.



Scene in the Texas oil regions.

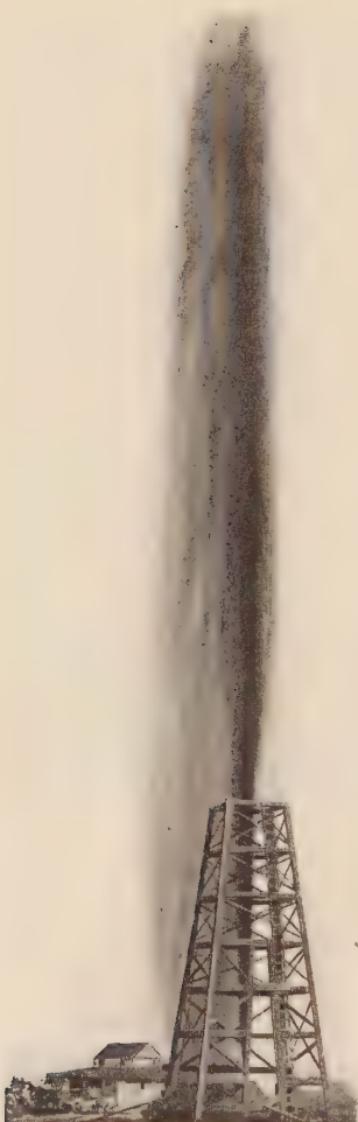
To-day the greater part of the artificial light used by man comes from petroleum. The amount taken from the ground every year is several hundred million barrels, or enough, if it were equally divided, to give more than thirty gallons to every family on earth. The places from which coal oil comes are widely scattered, and new fields are being discovered from year to year. Most of the product is now from Russia and the United States, more than half of all the oil raised coming from our own continent.

The Russian oil fields are at the eastern end of the

Caucasus Mountains, on the shores of the Caspian Sea, and Europe has other fields in Austria and Roumania. There are extensive petroleum beds in Burma, and in the islands of Borneo, Java, and Sumatra. There are also oil fields in northwestern Mexico not far from the boundary of the United States, and in Canada and Alaska. There are some in Africa, Australasia, South America, and in China and Japan. Our oil fields lie chiefly along the western slope of the Appalachian range in New York, Pennsylvania, and Virginia, in the basin of the Ohio River in Ohio and Indiana, Texas, Oklahoma, and Kansas, and also in southern California. In all of these places a great deal of oil is produced, and the product from them not only lights the most of the United States, but it drives the darkness from the homes of many people of every country of the world.

But what is the origin of petroleum, and how is it got out of the earth?

The first question is a difficult one, and scientists, who have studied as to how the world is made, answer it in different ways. Some say that it is altogether a mineral, and that it comes from the action of steam and carbon on certain metals which form a large part of the earth. Others suppose that it has come from the action of water on metals, and others that it has resulted through the decay of the countless plants and animals which swarmed the seas before the age at which coal was formed. They suppose that these plants and animals were in some way shut in under layers of rock, so dense that the air could not get to them, and that they decayed and formed this gas and oil.



"Petroleum rushes forth, spouting high into the air."

Sometimes there is so much oil in the rock, and it is so squeezed within its prison walls, that when the hole is

Now there are many kinds of rock, such as the sandstones, limestones, and others, the grains of which are not very close together, and other rock, such as slate, whose grains or particles are so compact and tight that neither oil nor gas can pass through them. The scientists think that the oil and gas were soaked up by these great beds of porous rock just as water is soaked up by a sponge, and that they are held there by the tight rock above, below, and around them. They are inclosed, as it were, in a prison, until man by boring through the tight rock lets them loose. In such prisons there is usually a brine at the bottom, with oil above, and perhaps gas upon top. When the roof of the prison is broken the gas and oil rush with great force to the surface, or, where the pressure is not so great, the oil is drawn up by pumps.

The pressure of these earth-prisons varies in different places.

made the petroleum rushes forth, spouting high into the air and flowing for days and weeks before it stops.

In the Russian oil fields some wells have been dug which spouted from sixty to one hundred thousand barrels a day, and in Texas a single well poured out four hundred thousand barrels of oil, covering the ground about and forming creeks of oil several miles long, before its force could be checked and the oil saved. The "Star and Crescent," another Texas well, threw a stream of oil six inches thick as high as a twelve story house, and this continued for several days before a cap could be put over the pipe, and arrangements made for saving the oil. One Russian well wasted a hundred thousand tons of oil before it could be capped, and another sent up a column of petroleum two hundred feet high, which ran off and formed a little oil lake near by. Another spouted forth sand and oil to a height of four hundred feet; and upon the pipe of a fourth a plate of cast iron weighing twenty-two tons was laid, but the stream of petroleum threw it aside as though it were paper.

In most of the oil beds the pressure is slight in comparison with that which produces these great spouters or gushers, as they are called. Some wells may not flow at all, and some yield only a few barrels per day, requiring pumps to raise the oil to the surface. Others flow steadily for weeks and months and then gradually diminish, after which the pumps are put in.

Some of the oil territories have continued to produce oil a long time, and in the oldest of them excellent new wells are occasionally found. In others the great flow is soon exhausted, and it becomes less every year.

33. OUR GREAT OIL INDUSTRY

THE first mention made of petroleum on our continent was by a French missionary in 1635, only fifteen years after the Pilgrims landed at Plymouth. He had visited the region under the surface of which the great oil deposits of western Pennsylvania lie, and he wrote of springs and streams coated with oil. Later the early settlers of Pennsylvania collected the oil for medicine. This was also done by the Seneca Indians, who laid blankets upon the ponds and streams and thus soaked up the petroleum, which they wrung out and sold. After a long time it occurred to some that if there was so much oil on the surface more might be found farther down, and in 1854 the Pennsylvania Rock Oil Company sunk a well which yielded from four hundred to one thousand barrels of oil a day. For some reason, however, this was abandoned; and it was not until five years later that the well was sunk which formed the beginning of our oil industry. This was after it was discovered that the oil could be refined and used for lighting. Then E. L. Drake dug a well near Titusville, Pennsylvania, and at seventy feet struck oil. The yield was not large. The well produced only a few barrels a day, but it showed the people that the oil could be raised and other wells were rapidly sunk.

From then on the borings grew deeper and the Empire well was put down. It yielded twenty-five hundred barrels a day, and a month later the Phillips well was producing three thousand barrels. By this time people were almost crazy over the fortunes to be made from petroleum. Hundreds of wells were sunk, and new oil fields discovered.

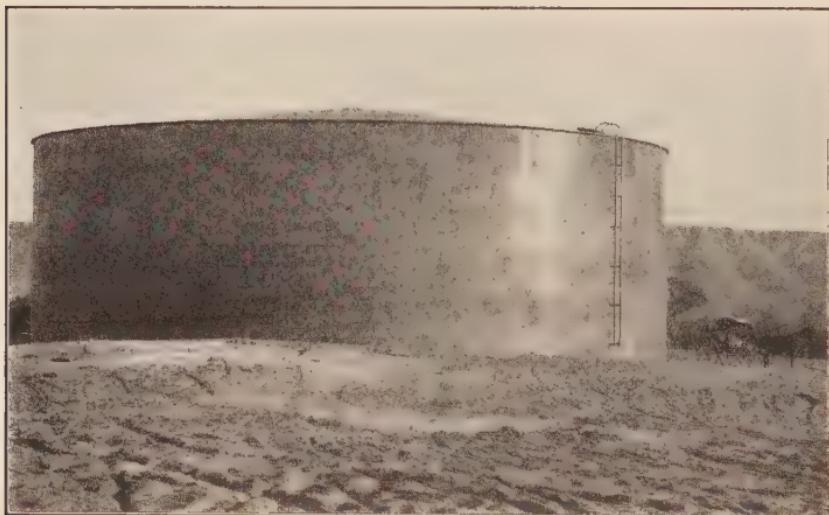
The miners bored their wells deeper and deeper, and some of the richest deposits were found at two or three thousand and more feet below the ground. So much oil was produced that it was difficult to take care of it. Great iron tanks, each holding from twenty to forty thousand barrels, were erected in the oil territory, and pipes were laid from them to all parts of the fields to bring in the oil.



Oil refinery.

As time went on more and more tanks were built, and tank cars were constructed for carrying the oil. Then the pipes were laid to Cleveland and other cities, where works were erected for refining petroleum, and in time extended, over the Appalachian Mountains, to the seacoast, so that the oil from the wells could be pumped there. We have now tens of thousands of miles of iron-pipe connecting our chief oil territories with the seaboard, the markets, and the works where the oil is refined. The pipe lines of Pennsylvania

alone if they were placed end to end would reach around the world; and there are other extensive piping systems in West Virginia, Ohio, California, Texas, and wherever oil is mined in large quantities. These pipes are of wrought iron. They are from four to eight inches in diameter and are usually laid two or three feet underground. There are pumping stations and storage tanks at every thirty miles along their course; or such stations may be placed otherwheres on the hills or where it is necessary to raise the oil, as it travels over the country.



Storage tank for oil.

The transportation of American oil to the homes of the other continents is also a great industry. It is now taken over the oceans in tank steamers, one of which, such as the *Andromeda*, will carry more than six hundred and eighty thousand gallons at a load. The oil is pumped into the hold of the steamer as it lies at our wharves, and remains there until it is pumped out again into the great storage

tanks at some seaport of Europe, Africa, Asia, South America, or Australia.

There is a great difference in crude petroleum as it comes from the earth. Some has been found which could be used for lighting without refining, but this is uncommon. Most of it is thick and dark colored, and it all contains materials which must be separated from that part of it which we use in our lamps. The crude oil differs also as to the field whence it comes. That of Pennsylvania, New York, and West Virginia is light amber in color, and is easily refined, while that of the Ohio and Indiana fields is darker and heavier and it contains considerable sulphur. The Kansas and Texas oils are still darker and heavier; and they, like the California oils, are being largely used as fuel on the railroad locomotives and for factories. The latter oils are less easily refined; they have a disagreeable odor, and, barrel for barrel, are not so valuable as some other oils.

But now let us see how the crude oil is treated to prepare it for lighting our homes. As it flows from the wells it is thick and dirty, and mixed with sand and water. It may be of a light yellow color or dark green, brown, or black. Its smell is offensive, and, if burnt, the odor might drive us out of our houses. All this must be changed before it is ready for use. In addition to the oil for lighting, about two hundred other products are made from crude petroleum, so that it must contain many substances of various kinds.

The crude oil first goes to the storage tanks, where the sand and water in it gradually sink to the bottom. It is then pumped through pipes to the tanks of the refinery,

which has many iron stills, furnaces, and other machinery. The oil is put into the stills and cooked, as it were, just the right amount of heat being supplied. As it grows warmer and warmer, the lighter particles rise in a vapor and pass out into coils of pipe, kept cold by running them through troughs in which cold water flows, or by their being set in cold water tanks. As the vapor strikes the cold surface of the pipes, it condenses and flows out at the other end of the coil in a stream of pure oil. This stream is very light and thin at the start, but it grows thicker and heavier as more heat is applied to the still. The first oil that comes out is benzine or crude naphtha, and the next, a little heavier, is the kerosene we use in our lamps. After that, with more heat, come the thicker, illuminating oils, leaving in the still a heavy, dark fluid from which lubricating oils, paraffin, and coke are made.

The kerosene is sometimes washed with acid and soda, and is sprayed through the air and treated in other ways to further purify it, in order that there may be no explosive gas left in it. It is important that it should not ignite too easily, and that its flashing and burning points should be high. By the flashing point is meant the lowest temperature at which the oil will give off a vapor which will flash or explode when a flame is brought near its surface. If this is not right, the lamp or can in which the oil is may burst, like a cannon, or break out in flames. If the burning point is too low, it may ignite before we expect it to do so. For this reason there are in some parts of our country laws which require all kerosene to be tested as to the degree of heat at which it will flash or burn; if that degree is too low, it must not be sold.

34. HOW GAS IS MADE

THE path along which we shall travel this morning is lighted by rays from water and stone. It seems strange to draw light from such things, but the world has many cities and towns which are lighted by gas made from coal, which is one form of stone, and from water, which is composed of two elements, hydrogen and oxygen. The hydrogen, when separated from the oxygen and ignited, burns with a hot, colorless flame.

Of these two gases, that from coal was first used. It is said to have been discovered about two hundred years ago by John Clayton, a bishop of Cork, in Ireland, who made it by distilling soft coal and catching the gas in a bladder. He had no idea of using it for house lighting, but looked upon it merely as a curiosity for entertaining his friends. He would take the bladder of gas and place it near the flame of a candle. He would then prick a hole with a needle or pin, and the gas, coming out, would take fire and continue to burn until all was consumed. The people were much surprised at this sight, because they could see no difference between the bladder used by the bishop and one filled with air.

It is said that the great Dr. Johnson, the man who wrote "Rasselas," once prophesied that London would be lighted by gas. He had seen a man climb a ladder to light one of the oil lamps then used for the streets. The lamp had just gone out, and Dr. Johnson noticed that the wick caught in a moment from the vapor or gas still rising from it. "Ah!" said he, "the day may yet come when London will be lighted by smoke."

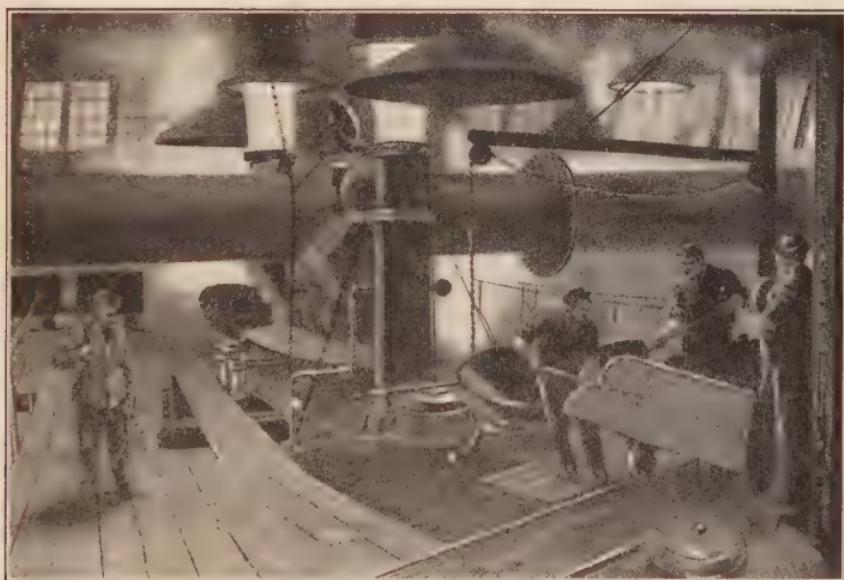
That remark of the learned doctor was uttered in the latter part of the eighteenth century. It was not long thereafter that a company was established for putting gas lamps upon the streets of London, and Paris was so lighted in 1820. In our own country Baltimore began to light its streets with gas in 1821, and Boston the year after that. The first man who is known to have used coal gas for house lighting was a Scotchman named Murdock. He introduced such gas into his own home in 1792, and soon afterwards into some cotton mills at Manchester, England.

But where did man get the idea that gas could be made out of coal? It may have come from watching a fire of soft coal where the fuel sometimes melts to pitch, giving forth a gas which bursts into flame. We may see that in almost any fire of bituminous coal as it burns in our grates. We can also test for ourselves the fact that there is gas in the coal. All we have to do is to fill the bowl of a clay pipe with coal dust and cover the top tight with clay. We can then put the bowl in the fire, leaving the stem sticking out. Within a short time the heat will drive the gas out of the coal and it will come through the stem in a thin stream which a match will turn into flame. It is after this principle that all coal gas is made.

But we can see the chief processes of manufacturing this light from coal and water by visiting the gas works of any large city. Suppose we take those of Washington, the capital of our nation. They supply much of the light for more than seventy thousand houses, and some for the White House, the Treasury, and the Capitol Building, although the latter places have electric lights as well.

The Washington Gas Works are situated near the banks

of the Potomac River, not more than a mile west of the Executive Mansion, where our President lives. They consist of large red brick structures filled with great furnaces, retorts, massive iron boxes, and other machinery for making the gas and also for purifying it so that it will furnish a clear and bright light; for according to law it must be



Inside the gas works.

twenty times as bright as a candle. Outside the buildings rise the mighty round tanks or towers for storing the gas until needed. They remind us of the petroleum tanks we saw in the oil fields, save that they are fitted into a framework so that they move up and down in great pits of water. Each tower has a diameter equal to that of the largest circus tent, and at the time of our visit some are as high as a ten-story house. Others are shorter, and the men tell us they rise or descend as the gas goes in or out.

We smell the gas long before we get to the works. The air has an offensive odor, and we wonder whether it will be dangerous for us to go in. We first visit that part of the establishment where the coal gas is made. At one side of it is the coal shed, an enormous building which will hold fifty thousand tons at one time. It is half full of soft or bituminous coal, for that is the kind used for coal gas. The men are wheeling it in iron cars across the way to the building containing the furnaces and retorts, where it will be cooked until all the gas has gone out.

We follow them and are led into a large room almost filled with what looks like a series of furnaces, each entered by a round iron door above which is an iron pipe as thick as a telegraph pole running up to its top. These are the retorts. Each consists of a huge, box-shaped vessel lined with fire clay in which the soft coal is cooked, the gas passing off through the pipe. There at one end we can see the men putting coal in. They load the black lumps into narrow iron troughs about eight feet in length and shove them in through the round, cast-iron doors. As they do so the flames stream forth, and, looking in through the doors, we can see the coal blazing away. In addition to its own heat each retort has that of a coke furnace beneath it, and the temperature is now about two thousand degrees Fahrenheit, or almost ten times that at which water boils. Now, the men have shut the doors and screwed them so tight that not a bit of gas can come out. The heat is melting the coal, and the gas is going up the pipe to the top of the retorts and from there into other pipes which carry it off to be purified.

Now let us take a lump of coal from those they are

throwing into the furnace and examine it. It seems typical of darkness rather than light. It is black, heavy, and solid, and it seems almost greasy. It is not at all like this piece of coke which one of the men brings to show us how it will look after the cooking. The coke is light and spongy, and its color is the gray of pig iron. The coal as it goes into the furnace contains, not only the coke and gas, but also tar, ammonia, sulphur, and other impurities. All of these materials, excepting the coke, are mixed with the gas when it flows up the pipes from the retort, and they must all be taken out of it before it can be used. This is done by forcing the gas through certain substances. It first goes through water, where the greater part of the tar and oily parts condense and some of the ammonia is washed out and afterward saved. It is then whirled round and round by fans which, as they revolve, dip into water and thus scrub the gas much as clothes are cleaned in a washing machine. It is by such means that most of the impurities are removed.

There are some impurities, however, which require further treatment. One of these is sulphur, which gives the gas a bad smell not unlike that of bad eggs. In some works this is taken out by running the gas through beds of powdered lime. Here at Washington it is done by passing it slowly through great iron boxes in the bottom of which are iron borings or filings, mixed with shavings of white pine. The shavings are used to keep the bits of iron apart, and to allow the gas to come into contact with them. Otherwise they would all sink together into a solid bed at the bottom of the box. As the gas goes through this mixture, the sulphur in it sticks to the iron, and after a time it has

all gone out of the gas. Other things are taken out in various ways, and at the end the gas is comparatively pure. It is now ready to be taken off into the great towerlike tanks, which, as we have seen, store the gas until it is used.

As we walk through the works we ask the men how they measure the gas, and they show us the big meters, each of which on a dial records the hundreds of thousands of cubic feet of gas which pass through. They tell us that the cubic foot is the unit of measurement, and that gas is of value according to the lighting power it possesses. The standard is the light of a candle, of a certain weight, burning at a fixed rate per hour. Ordinary coal gas has seldom more than sixteen candle power. This is not as much as the laws of the District of Columbia require, and the coal gas is therefore enriched with petroleum vapor, which increases lighting power.

The men say that one ton of soft coal should furnish about ten thousand feet of sixteen candle power gas, and that in addition it contains fourteen hundred pounds of coke, one hundred and twenty pounds of gas tar, and about twenty gallons of impure liquid ammonia. We collect specimens of the coal, coke, and tar, and of the other impurities for our museums, as we go through the works.

Leaving the department where this coal gas is made, we move on to the building where they are so treating water that it will burn and give forth a bright light. Is it not strange that we can make water burn? We have always considered it the opposite of fire and have employed it in extinguishing flames of all kinds. But there is no end to the wonders of chemistry. By a process which in principle is somewhat like smelting, some of the oxygen of water

can be removed, leaving a gas that will burn. It will not, however, give a good light without the addition of carbon, and this is supplied by adding petroleum vapor. In making water gas, steam is passed over coal raised to a white heat. Some of the oxygen of the steam unites with the coal and a mixture of partly burned carbon and hydrogen,



One of these tanks will hold one million cubic feet of gas.

called water gas, is formed. At the same time a small stream of oil is let in. This combines with the water gas, forming the rich illuminating gas used in most of our cities. This gas is also purified, being washed and scrubbed just like the gas we saw made from soft coal. It requires about fifty pounds of coal and four or five gallons of oil to make one thousand cubic feet of such gas.

In Washington city the water gas from anthracite, naphtha, and water is mixed with that from bituminous

coal before it is sent through the pipes to the homes of the people. Some other cities use water gas only, and in a few coal gas alone is consumed. All such gas is carried from the works through pipes to the gas towers or storage tanks, and is there kept and let out into the pipes of the city as the demands of the people require.

One object of these storage tanks is to force the gas into the homes of the consumers. Each tower is constructed in sections which fit together much like the rings of a telescope, and it is crowned with a gigantic inverted cup. The sections are so arranged that the gas cannot escape, and so that the walls and top will rise as the gas flows in. There is water in the bottom of the tank. The gas enters through a pipe at one side and passes out through a pipe at the other, being controlled by a governor which allows it to go just so fast and no faster. One of the tanks of the Washington plant will hold a million cubic feet of gas, and there is one in London that will hold twelve times that amount.

The gas is carried through the city in large iron pipes or mains laid under the streets, and it is taken from them into the houses through smaller pipes which connect by others, still smaller, in their walls, with branch pipes and brackets extending out into the rooms.

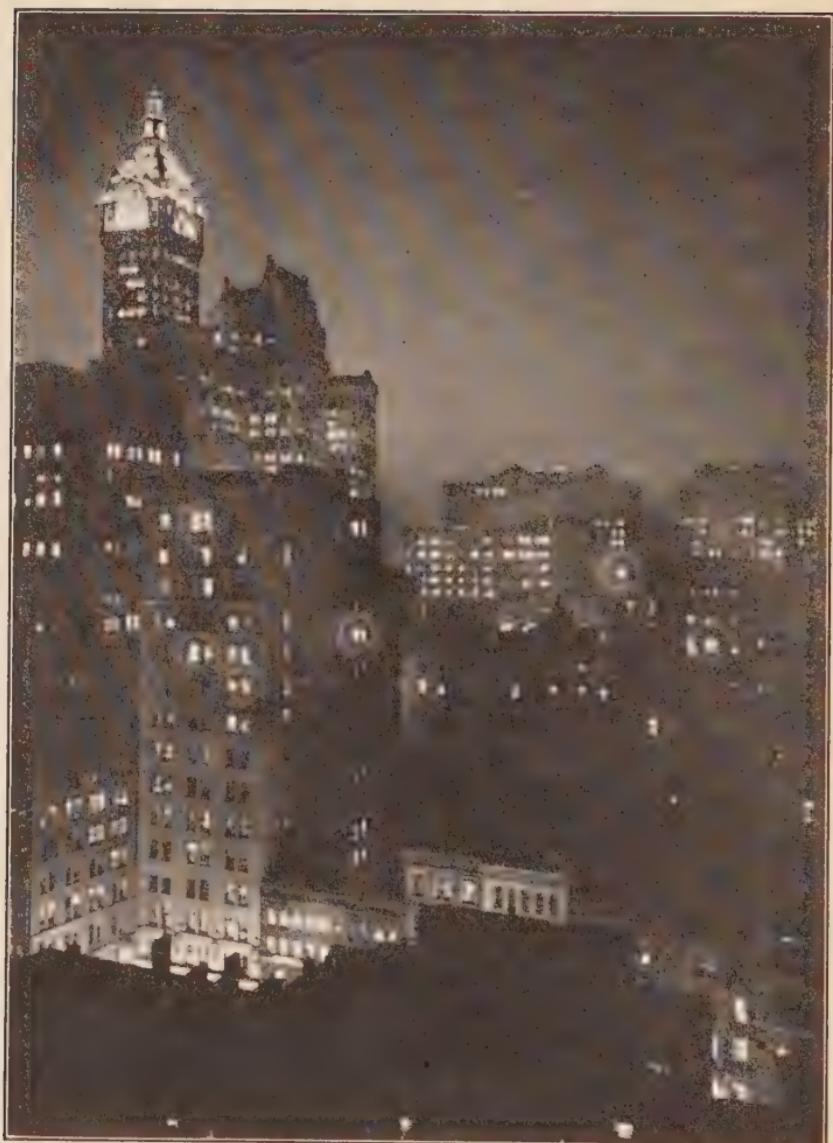
In addition to gas made in these ways, we have natural gas from the same source as petroleum; oil gas from petroleum, tar, and shale oil; air gas, produced by causing air to pass through the lightest of the petroleum vapors; and acetylene gas. None of these gases, however, is used to anything like the extent of coal gas or water gas, although acetylene is often employed for houses which stand alone in the country, and for villages and small towns.

Acetylene gas is made by adding water to calcium carbide, a material formed by heating coke powder and lime in an electric furnace. This is of such a nature that when water drops on it a gas arises which when ignited, gives a pure, clear, and very bright light.

35. LIGHTING BY ELECTRICITY

IN one of the fairy stories of the ancient Greeks the light of day comes from a strong and beautiful youth named Helios, who, in a chariot of fire drawn by four flaming horses, rises out of the east every morning and drives over the arch of the heavens to the west, where he is lost in the twilight of evening. It was thus they thought that the gods harnessed the sun and made him give daylight to man. It remained for man himself to harness the lightning, and force it to serve him at night or at any other hour he commanded. We all know that lightning comes from electricity, and that its flashes are of the same character as the brilliant blaze of the great arc light or the golden glow of the incandescent lamp. It is in this respect only that we may speak of man harnessing the lightning. It would be better to say that he has harnessed electricity; for the flashes which illuminate the sky are merely exhibitions of that mighty force.

It is hard to explain just what electricity is. It is only recently that man has known much about it; and it was not until within a generation or so ago that any one realized that it could be made to give light for our houses and streets. Even now there is a difference of opinion as to



(300) Night scene in New York, showing electric lights.

just how it works, and we shall probably discover a great deal more concerning it as time goes on. It is safe to say that it is one of the great forces of nature; one of the forms of energy which is a general term used for the various forces that make the wheels of the world go round. It is energy that moves all kinds of matter. Energy causes the sun to shine, the plants to grow, the fires to burn, and the winds to sweep to and fro. Energy makes heat and light. By it water boils and, in steam, it runs our railroads and factories.

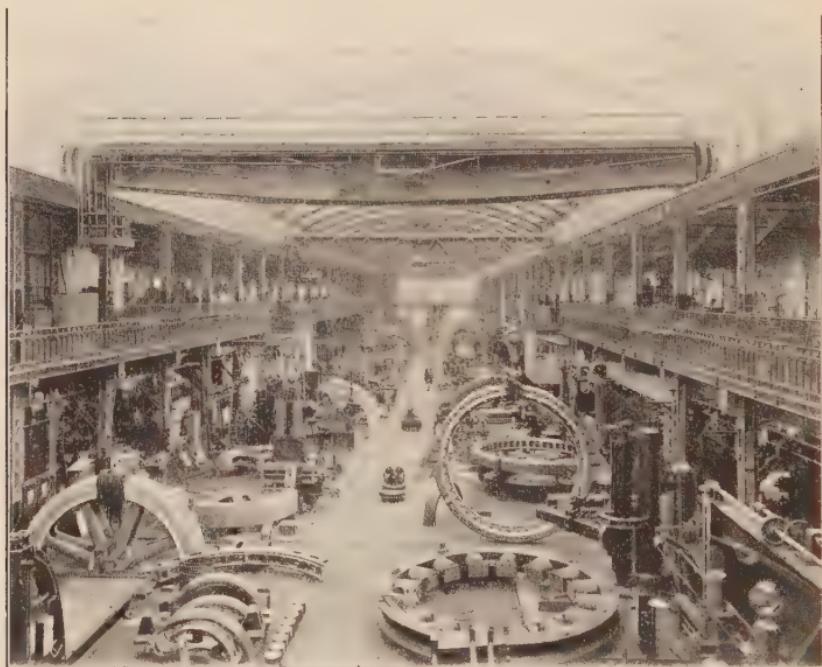
From energy in the form of electricity we have much the same results. Electric energy moves machinery of a thousand kinds. It turns the wheels of the electric car and automobile. It carries the whisper of the telephone, and through its brilliant lamps we are able to turn night into day. It is a kind of energy which seems more easily carried than any other, and there are certain materials through which it can be sent at lightning speed.

Among these are the copper wire and other mediums, called conductors, which we use for telegraphs, telephones, street cars, and the many things operated by the electric current. On the other hand, it is very difficult to force it through certain materials such as glass and rubber, which for this reason are called non-conductors. And so man, by using the right sort of matter in connection with it, can imprison this energy, and carry it where and how he will.

Moreover, it has been found that electric energy works in such a way that it will produce an intense heat if it is conducted through just the right sort of material in certain fixed ways. It will create fire; or if the material is right and inclosed in a glass globe in which there is no air,

it will come to a white heat and give out a brilliant light. This is the electric light of the incandescent lamp made by the medium within the globe turned white hot by the electricity going through it.

The electricity is carried to the globe by copper wire, and the ends of the threadlike matter or filament within



Where electric machinery is made.

the globe are fastened to the copper by fine wires of platinum, another metal that will carry electricity and at the same time withstand great heat. The platinum wires pass through the glass. The fiery thread or medium within the globe which looks gray or black when the electricity is not passing through it, is often made of vegetable fiber, and frequently of bamboo, which has been carbonized or turned

to charcoal by a special process. If it were out in the air, the electricity would burn it up at once, but confined in a vacuum or where there is little or no air it grows white hot, and is consumed so slowly that in a lamp of sixteen candle power, with the ordinary current, it should give out light for one thousand hours.

In the arc lamps, or glass globes of the size of a football or larger, which are often used for public halls and street lighting, the electricity passes through two sticks of black carbon as big around as one's finger. These are fitted into the top and bottom of the globe in such a way that their ends almost meet in the center, and are so controlled that they are kept just the right distance apart. The electricity flows through the carbons, jumping across the space between them and, as it does so, tearing carbon dust from the ends of the sticks, which the intense heat consumes. In such lighting the points of the carbons must first be brought together for a moment, when the current heats them white hot. After that they are moved the right distance apart and the electricity flows through the hot air across from one to the other. This light is not in a vacuum, the globe acting merely as a protector for the carbons.

But where does this force come from and how can it be harnessed so that it will do what we want? It was a long time before man was aware that any such thing existed, and it has been only step by step that we have learned what we now know. Long, long before Christ, a Greek, one Thales of Miletus, wrote that amber when rubbed would attract or draw to itself other bits of matter or light bodies placed near it. Several centuries later it was shown that other things would do the same, and as time went on

man began to suppose there was in nature some such thing as electricity. Many great scientists discussed it and among them was Sir Isaac Newton, the man who, when he saw an apple fall from the tree, reasoned out the law of gravitation. Benjamin Franklin thought that lightning was produced by electricity, and he tested it by his silk kite through which he received a shock from the clouds.

A little later men found that electricity could be easily carried by metals of various kinds, and an Italian named Galvani discovered the principle of the galvanic battery. Galvani had laid a machine containing electricity down beside some frog legs which his wife had just skinned and was about to cook for the family dinner, when he observed that the frog legs jerked this way and that. At first he thought there was electricity in the frogs; but he

afterwards discovered that the muscles and nerves were sensitive to the electric current of the machine and were thus affected by it. To learn more he hooked a pair of frog legs to a kite string and flying his kite with these at the end near an iron railing discovered that they began to jerk whenever they touched the railing, electricity apparently running down the string from the air although no lightning was flashing.



As a result of these and many other experiments men finally discovered that a continuous supply of electricity could be generated. It was found that it might be pro-



The 5000 horse power generators that convert the force of the cataract into the electric currents at Niagara Falls.

duced by chemical action, and also by means of the dynamo, which consists of two rapidly revolving blocks of magnetic iron about which wire has been coiled. The machinery for generating electricity is complicated, but



Metropolitan Building at night.

cars and forms the motive power for machinery of a hundred kinds.

we can see something of it by going to any large electric works such as those that run the street cars and light plants of our cities. It is enough here to say that by means of steam or gas engines, connected with such magnets, we are able to produce electricity, and that we can do this more easily and cheaply by such water power as is found in many parts of the world. The Niagara River at Niagara Falls, by means of a great tunnel through which the water drops upon turbine wheels, is able to generate a vast deal of such energy. The electricity is carried to Buffalo and other cities, and it lights their houses and streets. It also moves the street

Many of the cities and towns of the United States are now lighted by the waterfalls near them. Among the most remarkable of these is Spokane, Washington, where the Spokane River dashes down over the rocks with great force as it flows on towards the Columbia. Connected with the Spokane Falls huge spouts or pipes have been set into the bed of the river, and the force of the water falling through these is carried to dynamos, which generate a current that lights thousands of homes. Seattle is lighted largely by the force of the Snoqualmie Falls, which are forty miles away; and Los Angeles gets its light from Owens Lake, which is situated up in the Sierra Nevada Mountains two hundred and fifty miles distant, and is carried by many miles of canals down into and through the valleys to where Los Angeles lies.

The electricity used in San Francisco is also carried a long distance, and if we should travel over Europe, we should find many cities and towns which are getting their light and power from the waterfalls near them.



36. LAMPS AND BURNERS. HOW MATCHES ARE MADE

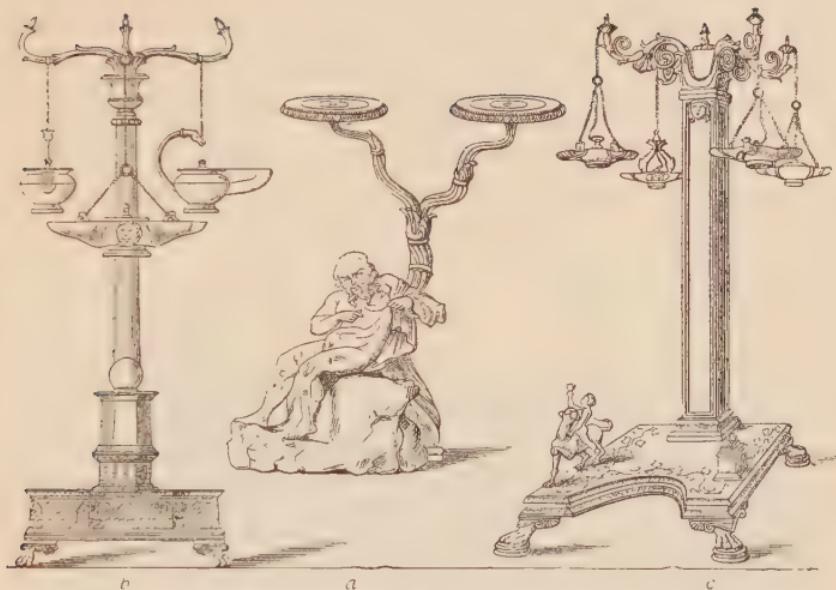
THE light from oil, gas, or electricity depends largely on the lamps through which the light comes. In electricity we have various inventions which greatly increase the illuminating power of the current. The Nernst lamp uses a small rod instead of a thread, and the light is not burned in a vacuum. The rod is a combination of magnesia and certain rare earths, and it gives out a brilliant

light. Another strong light is produced by using a metal called tungsten in place of the thread of carbon, and other electric lights are made by other materials.

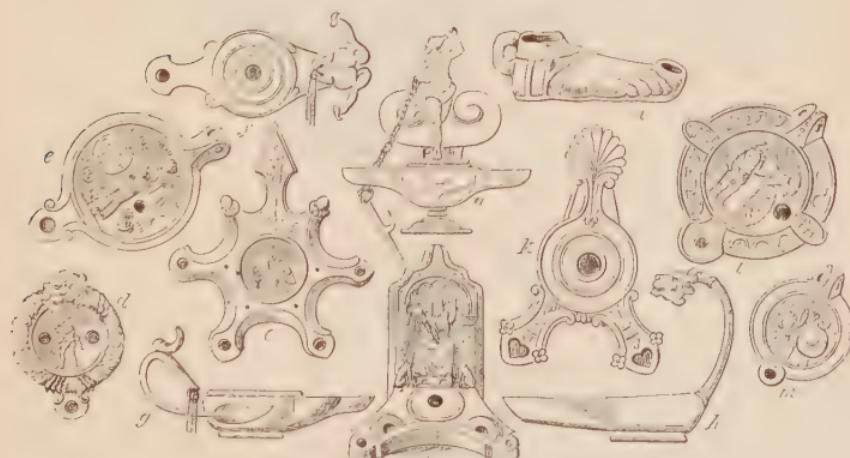
In gas lighting the flame is largely governed by the jet or burner through which the gas flows. This in the ordinary light is a short brass tube an inch or so long, and about as thick as a lead pencil. Inside it is a little strainer made of wire netting to catch any impurities in the gas, and at the top is a tip of fire clay or perhaps of aluminium, pierced by a little hole through which the gas comes.

The intensity of the flame is often increased by various burners, or by mantles which fit over the jet. The mantle, for instance, is a little white hood to be used inside a chimney. The hood is made of a net of cotton thread soaked with the oxides of certain metals. When the gas is lighted the cotton burns out, and leaves a skeleton network of these metals, which being heated white hot by the flame greatly increases the light. Such mantles are largely employed in street lighting, and also in public halls and houses where much light is desired.

The story of the lamp goes back to the beginnings of things. Homer, the ancient Greek who wrote for us the fairy tales of Ulysses, refers to the festival of lamps which was held in his day, almost one thousand years before Christ. Bronze lamps have been found which were used by the lake dwellers of Switzerland, who lived so long ago that we know little about them; and in the public museums are hundreds of lamps of stone, clay, and bronze which have been dug from the ruins of the great cities of the past. We have terra cotta lamps which were used in Babylon ages ago, bronze lamps which came from



Roman candelabrum (a) and lampstands (b, c).



Roman lamps.

Athens, and clay lamps from Carthage. I remember once while traveling through Egypt near the site of old Memphis, I bought a clay lamp which my guide said dated back to the times of the Pharaohs. It was dug from one of the tombs and the man who sold it offered me the little finger of a mummy which had been found near the lamp.

The first lamp was probably a shell filled with fat, with a bit of dried moss as a wick. Later came lamps of clay, and later still lamps of bronze, iron, and other metals. The Greeks and Romans made beautiful lamps stamped on the bottom with the name of the maker; and iron and brass lamps of many kinds were in use during the Middle Ages.

The light from all of these lamps was pale, smoky, and flickering, and it was not until modern times that man began to study how to increase the brilliancy of the flame. The first great improvement, which was made only a little more than a hundred years ago, was the flat, woven, ribbon-like wick, fitted into a frame so that only a small surface could be burned at a time. Then came the round wick or Argand burner, named after the Swiss who invented it, and later still the student lamp, made by a German. Argand used an iron chimney for his light, with an opening through which the flame could be seen; and it was one of his workmen who first suggested chimneys of glass. This man was trying to heat a bottle over the lamp when the heat cracked off the bottom. At the same time the glass grew very hot, and he dropped it over the flame. The result was that the flame shone out through the glass, and gave a steadier light than could be produced by the sheet iron chimney. It was in 1800 that Carcel made a lamp

with a clockwork attachment by which the wick was raised bit by bit as the clock ticked; and later still small hand lamps were made of tin, brass, and pewter.

The first lamps used in the United States were those brought over from Europe by our colonial forefathers. The Indians then lighted their wigwams with pine torches,



Colonial lamps.

and the only tribes which had lamps were the Eskimos, who used shallow vessels of stone, bone, or clay in which they burnt the oil of the seal, walrus, or whale, with dry moss as a wick. Such lamps are to be found in Alaska to-day.

The chief lamps of the Pilgrims were known as Betty lamps. They were made of forged or cast iron, and were often of a pear shape with a place for the wick in the

top. Others were like candlesticks, with a vessel on the top and a saucer to catch the oil if it dripped down or ran over. The first of the Bettys were imported from England, but later on they were manufactured at Portsmouth, New Hampshire, and Newbury, Massachusetts, and, for this reason, were known as Portsmouth or Newbury Bettys.

We have already seen how Benjamin Franklin gave us some of our first knowledge of electricity through flying his kite, and how he invented one of the stoves of our colonial days. We are also indebted to him for an early improvement on lamps. Franklin's father was a candle maker in Boston and when Benjamin was a little boy he had to cut the wicks for the candles and fill the molds with the melted grease. He did not like the work, and when he grew to a man, he planned a lamp which would



Colonial lamps.

give out more light than several of the candles he had made as a boy. This lamp had two round tubes through which two loosely braided cotton wicks ran, extending down into a tube of whale oil. Franklin did not patent this invention, but it came into general use, and proved to be better than any lamp employed up to that time.

After this many other improvements of more or less value were made, but they were all for lamps which burnt lard or fish oil, and it was not until the great lighting value of coal oil was discovered that we had the lamps which give the brilliant light of to-day. For these we are indebted largely to Samuel Kier, a druggist of Pittsburg, who was one of the first men to refine coal oil and employ it for lighting. In the latter process he surrounded the flame with a glass chimney, using an Argand burner, thereby producing a beautiful light. Kier did not invent the chimney, for as we have seen that had already been discovered by the man who was working for Argand, but he adapted it to the coal oil lamp, and it soon came into general use.

Now let us shut our eyes, and for the moment suppose that we are little children living two hundred years ago. Let each imagine that his parents have told him to light the fire or the candle and wonder how he is to go about doing it. He cannot use matches, for such things have not yet been invented. He takes up a splinter and starts towards the fireplace. But alas, the fire has gone out, and there are only ashes and dead charcoal on the black hearth. The only ways in which he can get light are by the methods of fire making then known. He debates for a moment whether he shall take a flint and strike it on steel, so that

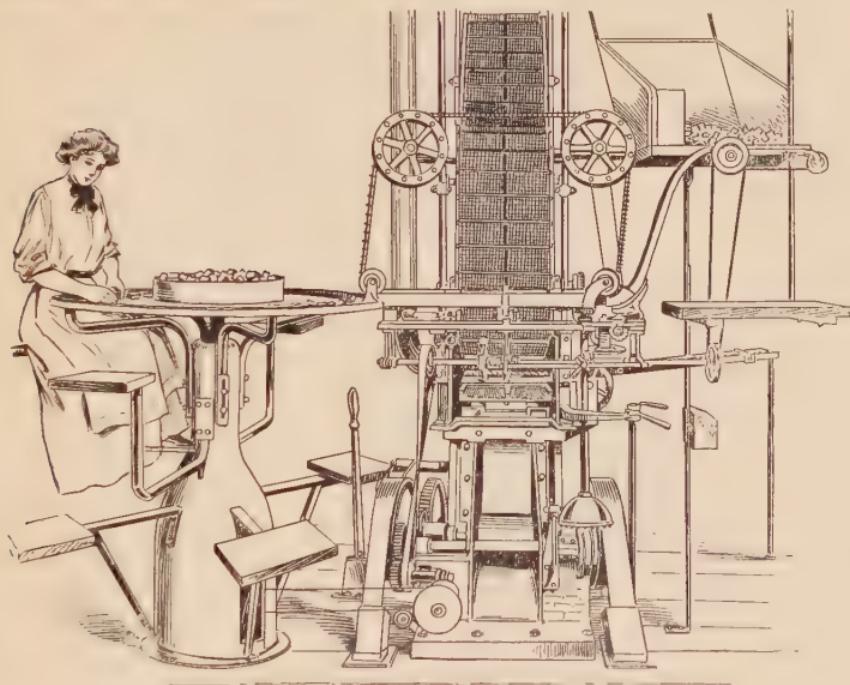
the sparks will fall on some dry tinder or kindling, which he can then blow into a flame; or whether he shall roll one stick of wood rapidly around in a hole made inside another, and by friction gradually bring smoke and a blaze. Either way is difficult, and as he has had no experience he will probably fail.

Indeed, the light which we now get by simply striking a match was hard to create only a few generations ago. Then every family covered the coals in the fireplace with ashes before going to bed, and kept at least one fire burning throughout the year. Our colonial forefathers had boxes of flint and steel in their houses; and as they found that scorched linen would quickly ignite, they saved their old handkerchiefs and worn-out sheets and charred them, in order that they might catch upon them the sparks from the flint. The guns had flintlocks, and thereby lit the powder, and the hunter often used his gun flint to start the camp fire.

It was not until 1827 that the lucifer match, that could be lighted by friction, was invented, although it was known that the materials used in making it could be ignited long before that. The first matches were made by dipping little sticks of wood into a compound of brimstone, chlorate of potash, and some other materials. They were then dried, and were lit by drawing them through a piece of folded sandpaper. Later they were made so that they would strike upon being drawn over any rough and dry surface; and now, after many improvements of various kinds, matches are used throughout the world.

We make so many matches in the United States that we could each use five every day and have some to spare. We produce so many in one year that if they were all laid end

to end, they would reach four million miles, or, if placed in rows side by side, would make a band around the earth more than one foot in width.



Match-making machines.

The first matches were made in England. The splints were cut by hand, and the manufacture was so costly that they sold at the rate of three or four for a cent. Then machines were gradually invented, and now they are very cheap. We have single machines which will make four million matches a day.

The wood most commonly used for matches is pine, thoroughly dried and sawed into match lengths. The blocks are then put into an automatic feeder, which carries them to the machine where they are cut into shape. The machine cuts forty-eight matches at one stroke, and it

makes several hundred strokes every minute. At the same time it sticks the matches in a flexible cast-iron band, where they stand out like the bristles in a brush, and upon which they travel around wheel after wheel, dipping the ends into the vats which give them their caps of sulphur, paraffin, phosphorus, and other lighting materials. The matches, still in the band, are then carried through blasts of cool air, until they are dry and ready to pack. These machines are reliable. They will not handle broken matches, and the dust and splinters drop out and are carried down into the furnaces which furnish the steam for the works. Each machine will turn out several million matches per day, and it requires only twelve hands to operate it.

The matches are packed, by girls, into boxes which contain from sixty-five to five hundred each. The girls have seats at circular tables, which revolve as the matches fall on them. The boxes are also made by machinery, the sheets of pine or straw board of which they are composed going in at one end and coming out at the other in boxes. This machinery saves a great deal of labor.

The match business is done in numerous factories, a single one of which turns out as many as one hundred million matches per day. They make matches of wax and paper as well as of wood. They manufacture also the safety match that lights only upon striking the sides of the boxes, which are coated with a special preparation of phosphorus and powdered glass or emery that causes it to burst into flame. There is no phosphorus in the head of the safety match ; but this is put on the box, and when the match is rubbed over it the explosion occurs which produces the light.

37. THE OLD OAKEN BUCKET AND ITS
SUCCESSORS

“How dear to this heart are the scenes of my childhood,
When fond recollection presents them to view!
The orchard, the meadow, the deep-tangled wildwood,
And every loved spot which my infancy knew !
The wide-spreading pond, and the mill that stood by it,
The bridge, and the rock where the cataract fell,
The cot of my father, the dairy-house nigh it,
And e'en the rude bucket that hung in the well—
The old oaken bucket, the iron-bound bucket,
The moss-covered bucket which hung in the well.

“That moss-covered vessel I hailed as a treasure,
For often at noon, when returned from the field,
I found it the source of an exquisite pleasure,
The purest and sweetest that nature can yield.
How ardent I seized it, with hands that were glowing,
And quick to the white-pebbled bottom it fell ;
Then soon, with the emblem of truth overflowing,
And dripping with coolness, it rose from the well—
The old oaken bucket, the iron-bound bucket,
The moss-covered bucket arose from the well.”

THE old oaken bucket is rapidly becoming a thing of the past. The modern pump has taken its place, and in our cities and towns the public works which give every home its water supply have consigned it to the things forgotten. Even far out in the country, upon many of our farms, we have harnessed old Eolus, whom the Greeks regarded as the God of the Winds, and have made him turn the wheels of the windmills which operate our pumps, and, in many instances, are making the gasoline or steam engine do the same.

The methods by which we draw water from the depths of

the earth, and send it to every part of our houses, are among the wonders of this world of industry through which we are traveling. They do not seem very remarkable to us, because they are before us every day. But should we investigate how our little world brothers and sisters of the nations far away procure water, we should see that we are far better off, and be thankful.



The old oaken bucket.

else. The boy draws up the water and carries it in two great pails fastened to a framework which rests on his back. Each family pays so much a day or month for its water, and you may be sure that the children are warned against wasting it. It is so costly that the family washings are taken to the streams; and as for bathrooms, they are almost unknown.

It is much the same in China and India. In the latter

Suppose, for instance, we make a visit to one of the smaller cities of Korea. The water comes from wells and it is taken from house to house by men or boys who do nothing

country water-carrying is a regular trade followed by certain families or castes from generation to generation. In the cities of Egypt drinking water is sold on the streets, and in Manchuria the water man has a great samovar or tea pot, from which he sells it steaming hot to his customers. In Morocco and Algeria the water is drawn from the wells in goatskins and carried in such skins through the streets on the backs of men. In Tripoli I have seen it peddled about from large barrels slung across the humps of grumbling camels, which knelt beside the wells and wept real tears while they were loaded.

In many parts of the world the fetching the water is the work of the women, just as cooking, sewing, and dish washing are with us. This is especially true of Palestine,



A country home water plant.

where girls may be seen at the public wells awaiting their turn, as was Rebecca when young Jacob met her and fell in love with her. The little girl of the Holy Land begins to carry water almost as soon as she can walk. At first she has only a small jar which she bears on her head. As she grows older this becomes larger, so that when full grown she is able to carry three or four gallons. Such a jar

when filled weighs thirty or forty pounds, but the woman balances it on her head and walks along without touching it.

In countries like those referred to the water supply is often from springs or streams, or cisterns and pools. Most of the water of Jerusalem is from cisterns, each of the larger houses having one in the court in its



Algerian water carrier.

center. Outside that city is the Pool of Siloam, and from other pools comes the water used by many homes. In some parts of Australia the people rely upon the rains, which fall copiously during a part of the year. The rain from the roof is carried by spouts into great tanks of galvanized iron, which rest upon the porches. The water is

cooled for drinking by putting it into canvas bags and hanging them where the wind blows. Some of the water soaks through the bag, and the evaporation of this makes that inside as cool as though fresh from a spring.

In regions where there is no rain for a part of the year, cisterns are very important. They are usually made of stone or brick so cemented together that they will hold water; and they are placed where they will catch the rainfall. Many of the ancient cities had such storage tanks; and, as we shall see later, our own cities have reservoirs in which the water from streams or wells is stored and held to be let out as needed.

Some of the most remarkable of the ancient cisterns were those of Carthage, constructed about 500 B.C. They were fed by the rains, and by springs far away in the mountains, the water being carried in great stone troughs built high up above the ground on pillars of masonry. These cisterns could supply six million gallons of water a day. They were enormous barrel-shaped caverns eighty feet thick and more than four hundred feet long, with pipes running from them to the various parts of the city. When I visited the site of old Carthage a year or so ago, I found most of these old reservoirs in ruins with Arabs living in them.



Water carriers, mid-Africa.

In one a Bedouin woman was grinding corn between two stones, and in another was stabled a tiny gray donkey with a pretty little Arab girl standing beside it.



Cisterns of Carthage.

Others of the cisterns have been repaired, and some are now used to supply water to the towns and villages near by. These are thirty feet deep, and five hundred feet long. They are connected with steam engines which do the pumping. The old aqueduct has been repaired and with some modern additions it now gives water to the city of Tunis, which is not far from where Carthage once stood.

In olden times and indeed until recently a great part of the water used by man came from dug wells. This was so in America during our colonial days, and it is still true of many of the less civilized countries of the world. In India wells twenty or thirty feet in diameter have been dug far down into the earth. They are often used for irrigation, the water being drawn by bullocks in great bags of cow-

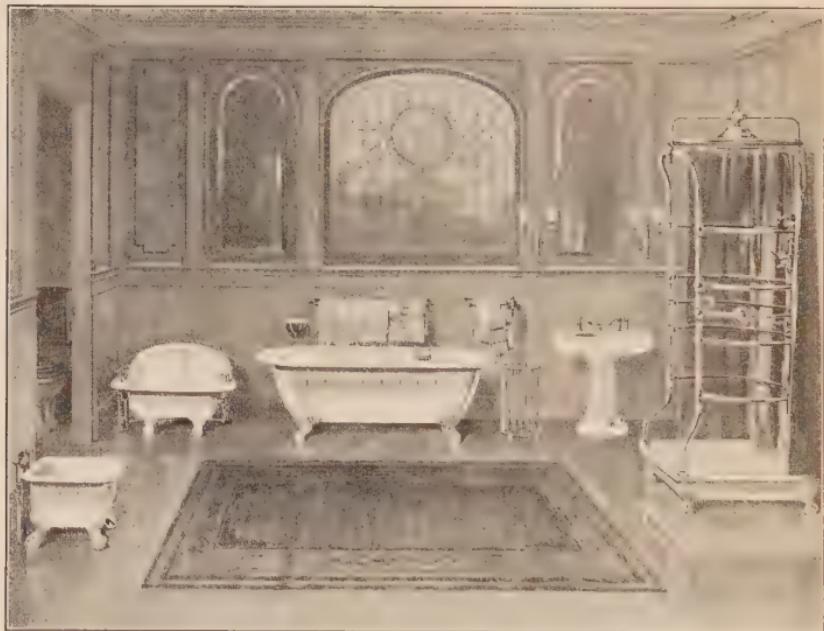
skins and poured into canals through which it goes over the fields. Egypt has many wells worked by the sakiyeh, a wheel turned around by a blindfolded bullock, camel, or water buffalo. The wheel has cogs which fit into the cogs of a vertical wheel to the rim of which clay jars are fastened. The vertical wheel extends down into the well, and as it turns the jars dip into the water and fill, emptying into a trough as it turns. There are wells in all the oases of the Sahara, and in the fertile spots of most desert regions. There are many in China and Japan, and in Europe, and in most other countries of the world.



"The sakiyeh, a wheel turned around by a blindfolded bullock."

Our wells of to-day are different from those of the past. Instead of digging a great hole in the earth and rock and walling it with brick or stone, we now use machinery to

drill or bore a hole from three to eight inches in diameter far down into the earth, and tap the porous rock into which the water from above has drained. This rock is often surrounded by other rock of such a nature that the water cannot pass through it, the porous rock thus forming a spongelike reservoir which holds the water. Such rock



A modern bathroom.

may lie not far from the surface, or it may be hundreds of feet below it with hard rocks above. Some of the bored wells are half a mile deep, and several have been sunk more than a mile straight down through the rock. There is one at Pittsburg which is more than forty-six hundred feet deep, and another at St. Louis which measures over thirty-eight hundred feet. One of the deepest of such

wells, near Leipzig in Germany, goes five thousand seven hundred and thirty-five feet down into the earth.

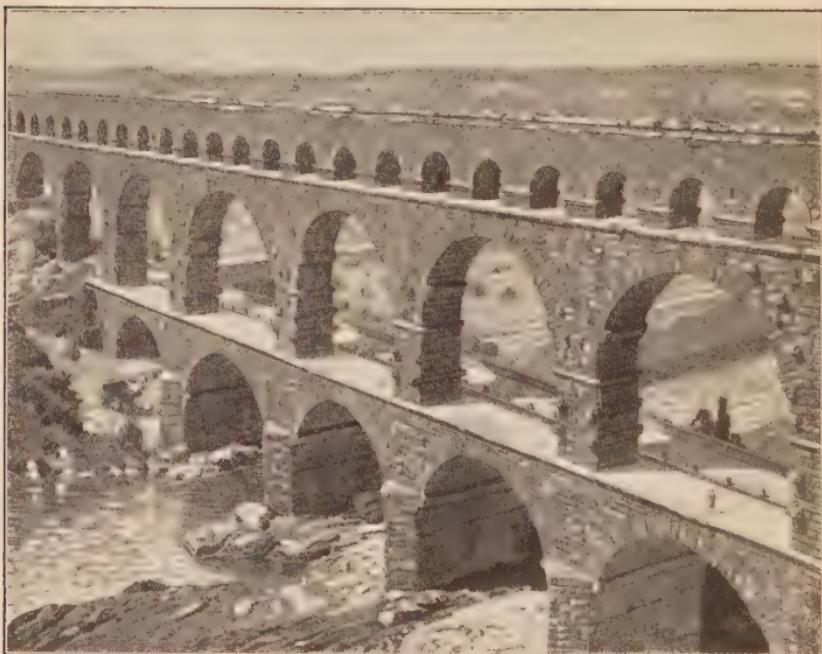
In drilling such wells when the porous rock is first struck the water often rushes up with great force. One was put down near Paris which yielded more than five million gallons a day, throwing a column of water to the height of a five-story house, and there are several in Australia which flow one million or more gallons every twenty-four hours. In the Australian wells the water often rushes forth in such quantity that it eats out a channel many miles long through which it runs. One well there has produced six million gallons a day, and some others over one hundred thousand gallons an hour, furnishing water for vast flocks of sheep and serving also to irrigate thousands of acres of land. Most of the wells, however, yield only a few gallons per minute, and pumps worked by wind, steam, gasoline, or electricity are required to raise the water to the surface. Such wells are known as artesian wells, the name coming from the province of Artois in France, where the first deep wells of Europe were made. They are now to be found all over our country, the water from them being pumped into high tanks built upon a framework of steel near the houses or barns.



38. THE WATER SUPPLY OF GREAT CITIES

THE waterworks of our great cities are far more extensive than any attempted in the past. More water is now used than ever before. We require it, not only for scrubbing, cooking, washing, and bathing, but for water-

ing our lawns and streets, and for manufacturing purposes. New York, Chicago, and Philadelphia each use several hundred million gallons a day, and many of our cities daily consume more than two barrels of water for every man, woman, and child in them. In figuring out how much water a city should have, some engineers estimate the amount at fifty gallons or upwards per person each day, and this is so much that only our modern waterworks can supply it.



Roman aqueduct.

It is an important question with every city, town, and village as to where it shall get its water supply and how it shall be carried into the houses. In some great cities the water is from rivers and lakes, in others from springs and

deep underground wells, or from reservoirs which are often made for the purpose, far away in the mountains. Much of the New York water comes from the Croton River and



Aqueduct across Harlem River, New York.

much of that of London from the Thames. St. Petersburg is supplied by the Neva, Berlin by the Spree, Hamburg by the Elbe, and Rotterdam by the Rhine. In our own country, Washington, Cincinnati, Louisville, St. Louis, Pittsburg, and Philadelphia are among the largest cities supplied by the rivers on whose banks they stand. Every one of us can probably tell what the names of these rivers are and mention other towns which get their water in the same way. The cities of the Great Lakes are supplied from those great natural reservoirs and the water of many of the big cities of Europe has a similar source.

At the same time some other cities draw their water from under the ground. This is the case with Indian-

apolis, which stands over a bed of water-soaked limestone into which numerous wells have been bored. The wells are on the average about three hundred feet deep, and



Reservoir and standpipe, New York.

some of them are ten inches in diameter. They produce many millions of gallons of water each day. London gets some of its water also from a chalk bed below it, but even this and the rivers do not furnish all that it needs and it is now planned to bring water in pipes from the mountains of Wales, which are one hundred and eighty miles away.

But how do the city works force the water into the houses? We can each find out as to his own town by visiting its waterworks, and this I advise you to do. The methods are different in different cities. The water is sometimes distributed by gravity from reservoirs or lakes,

or from streams higher up than the highest roofs of the houses. This gives a great force and when the pipes are opened the water may be thrown high enough to be used when the buildings catch fire. In some places the water is pumped by machinery from other sources into reservoirs at the right elevation. Or it may be forced into stand-pipes, or pumped directly into the water mains with such a force that it will go through the houses and have also a pressure sufficient to protect them from fire.

In every case the water flows from the works through the chief streets of the city in great mains, and is carried from them to the side streets in smaller pipes, and by pipes still smaller into the houses. These pipes are usually of



Croton dam.

iron, and in every large city, taken together, they are many miles in length. The cost of making the reservoir and of putting in these pipes, added to the expense of the ma-

chinery connected with the waterworks, is great. It is easily paid by the consumers, however, each house being taxed a few dollars a year according to the water used in it.

There is one thing we almost always consider as to our water supply. This is that the water be pure or at least free from such germs and bacteria as might make us ill.



Irrigation canal, Washington.

The large wells in which hung the old oaken buckets were often near stables and other buildings from which foul matter sank down into the soil and drains, thus causing fevers and other diseases. In the artesian or bored wells, the hole is small and it often goes down hundreds of feet through the rock. Nevertheless it should be kept far away from any place from which foul stuff might seep in, and the water should be carefully examined from time to time that we may know it is good.

There are several tests which may be made, and it is always best to be careful. If there is any doubt whatever, the water should be rejected, or sent to a chemist who can tell you what it contains.

Indeed, the purity of water is now thought to be so important, that most of our cities have built great settling reservoirs and filters through which the water is passed before it is let out into the mains of the city. In some places it is run over beds of gravel and sand, which are changed from time to time as they become filled with impurities. There are at Philadelphia works of this kind which filter millions of gallons a day, and Washington and other places have fine filtration plants. In Washington the water is brought from the Great Falls of the Potomac through an aqueduct to a reservoir, from which it passes on through another aqueduct into the filtration beds. Here it is conducted into twenty-nine great chambers built under the ground. These chambers are made of concrete and their floors are covered to a depth of four feet with beds of fine sand and gravel. The water flows over these beds and drains through them, passing out clean and clear into a reservoir or lake from which it goes into the pipes of the city. Each of the chambers will filter three million gallons a day, and from sixty to seventy-five million gallons of pure water are thus daily furnished to the people of our national capital.

39. FURNITURE

THE object of our journey to-day is to learn about the furniture which forms to a great extent the life of the home and a large part of its comfort. We first visit Japan.

The houses here are comparatively bare. There are no beds but thick wadded quilts laid on the soft white mats of the floor, and the only tables are little low portable ones which are used chiefly as trays for bringing the food in at the meals. There are neither sofas nor chairs. The people sit on their heels, and when one writes a letter he rests his paper on his knees or perhaps lies on his stomach and writes on the floor.

Crossing to the mainland of Asia we observe that the Chinese of the better classes have bedsteads which are often beautifully carved, but they are without springs and usually without mattresses. They have chairs, but the backs are straight; and the cushions are so thin that we might as well sit on hard wood. Many of the poorer Chinese sleep upon ledges built in one side of the room and heated, as we have already seen, by flues running under them. The Koreans sleep on the floor and their tables are like those of Japan. As to tableware, all these people have beautiful porcelains, and all use chopsticks instead of the fork.

In the Philippine Islands the poorer people sleep upon a framework of bamboo canes upon which matting is laid; and in India the most common bed is a rude wooden frame with a network of ropes as thick as a clothesline stretched over it. The bed is so small that a grown man must bend up his legs and lie "spoon fashion" upon it. The East Indian peasant's home is usually a hut, and his furniture consists of little more than a table, a few stools, and a bed. He has a set of brass bowls to drink from, and these are scoured so that they shine like gold. The Burman sleeps upon mats, and his pillow is a little frame of bamboo,

which rests under his neck. His dishes are bowls of lacquer, and his cups ladles of coconut shell.

The native African sleeps on a bed of grass or leaves, or perhaps a coarse mat which is rolled up during the day; and the same is true of the many tribes of the islands of the Pacific Ocean. In Mohammedan lands the houses have divans covered with soft cushions on which the people

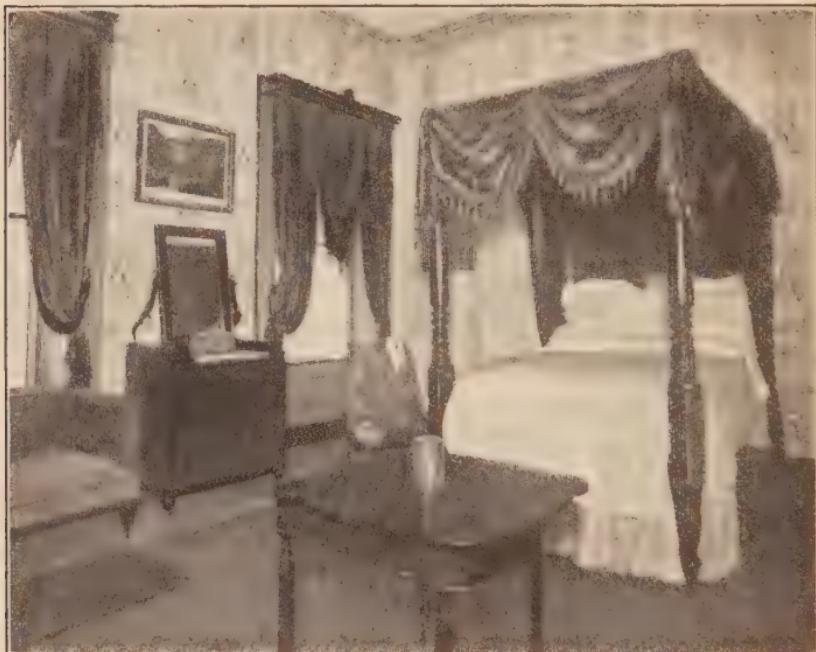


In a Filipino home.

sit and sleep, and the tables are often brass trays on a framework of wood. They use dishes and bowls at their meals, but the table is set without knives or forks. Every one has his own knife and spoon, and he eats with his fingers. In Europe and South America the people use beds, tables, and chairs much like our own, and they have about the same tableware.

As we journey on from country to country we observe that the furniture used by a people is to some extent a sign of its civilization. The first men slept upon grass like

the African savage. They sat on the ground and their tables were logs and flat stones. After that they built ledges which they covered with skins; and then made stools and rude tables of one kind or another. The ancient Egyptians and Greeks had tables and chairs; and the Romans had



President Jackson's bedroom at the Hermitage.

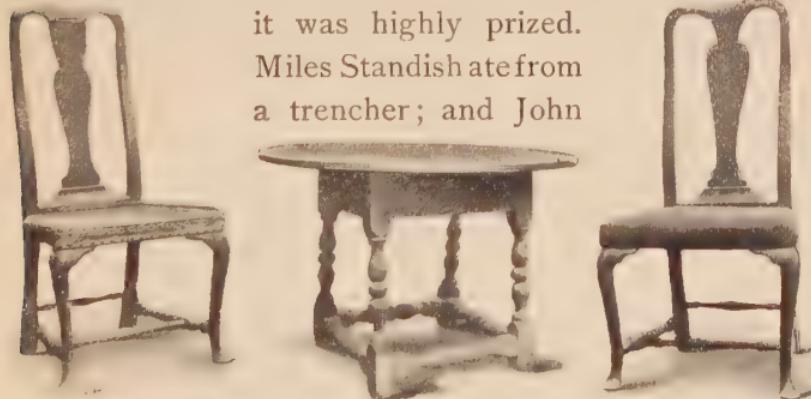
couches about their dining tables upon which they lay at their meals.

During the Middle Ages the beds of the rich were luxurious. Sheets of fine linen were used, and the mattresses were covered with silk. The beds were enormous. Queen Elizabeth had one which was seven feet wide, and certain kings then held their receptions in bed. The beds were covered with hangings, and the posts at the corners ran

almost to the ceilings. This was the nature of the better beds of our country in colonial times. George Washington and others of our early presidents slept inside the "four poster"; and it was such a bed that Andrew Jackson had. We now regard inclosed beds unhealthful, and think that one should have the windows wide open and sleep under sheets and light blankets with nothing about him to keep out the air.

In our colonial days the dining tables were often long, wide boards laid upon trestles shaped like a sawhorse, which were taken apart and placed against the walls after meals. The tablecloth was called a board cloth. It was often of homespun linen made in the family. Our first settlers had but little tableware, and it was some years before the two-tined steel fork came into general use. They had knives, spoons, and cups, but trenchers or wooden platters took the place of our plates, and glass-

ware was so rare that
it was highly prized.
Miles Standish ate from
a trencher; and John



Winthrop, the Governor of the Massachusetts Colony, brought the first fork to America in 1633. Silver knives and forks came into use soon after the Civil War.

At that time but few families had china and there were no saucers or covered dishes. There were seldom enough cups to go round, and only enough chairs or stools for the grown-ups. Some families had a narrow bench on each side of the table, and the children often stood behind those who sat there and the food was handed to them. In other

places the children stood at a side table and brought their wooden plates to the main table for more food, when their first portion was eaten.



To-day the poorest of us have enough knives, forks, and dishes for all the children, and every little one has his seat at the table. We have comfortable beds, and easy chairs of all kinds. Our floors are covered with carpets and rugs, and many of us live in more luxury than the kings of the past.

Indeed, we now require so much for our homes that a great industry has grown up to supply the demand. Thousands of workmen are kept busy making furniture and their output is enormous. We have seven cities each of which produces from three million to thirteen million dollars' worth of furniture per annum. The chief of these are New York and Chicago, the two largest cities of our country, but next comes Grand Rapids, Michigan, which makes a specialty of such manufacture.

Grand Rapids has over five hundred furniture factories, and it has many thousand men who do nothing else but make bureaus, beds, tables, and chairs, and other things for

the home. The industry began when the city was still surrounded by forests of hard woods, and now although these have been cut away it still thrives on account of the skill of its workmen, and the fame which its furniture has for beauty, cheapness, and excellence of construction. Twice a year the city has furniture fairs to which merchants from all parts of the United States and even from



Furniture factory.

other countries come to see the new patterns and to buy for their stores. In some years many thousand people visit these fairs, and the sales amount to as much as two hundred million dollars. The town has great exposition buildings for showing its wares.

But suppose we visit one of the large furniture factories. They cover several acres and are filled with all sorts of cutting, sawing, planing, and carving machines. Much of the wood comes from far-away parts of the world. There is mahogany from Cuba, Central America, and Africa;

teakwood from the jungles of Siam and Burma; rosewood from the valley of the Amazon; bamboos from Japan; and rattan from Borneo and other islands of the Dutch East Indies. There are bird's-eye maple, oak, walnut, and cherry from different parts of the United States, and cheaper woods from our great forest belts. Some of the woods are costly, and especially the mahogany, a single log of which may be worth several thousand dollars.

Indeed, many woods are so valuable that they are used in thin sheets, which are pasted or glued to other wood so firmly that the two seem as one. The fine woods cover the cheap woods like a skin, and are so fitted on that no one would suppose that the furniture was not wholly made of the costly hard wood. Such work is called veneering. The fine wood is sliced or sawed by delicate machinery into great sheets, not so thick as the cover of this book. These are then treated so that they can be wrapped around a column, or made to follow the curves of an armchair or bedstead. The veneer is put on rough, and then smoothed and polished so that it shines like a mirror.

Most of our fine furniture is veneered in this way, the oak, mahogany, maple, and birch being glued upon pine, poplar, or other cheap wood. The core, as the cheap wood is called, is usually covered with two thicknesses of veneering, the grain of the wood of one running in one direction and that of the other crossing it at right angles. This prevents cracking, and, if properly done, makes the furniture more durable than though it were solid and of one wood throughout.

The work of polishing and carving is now largely performed by machinery. The wood is smoothed by great

drums covered with sandpaper, one of which will do as much as twenty men working by hand; and the carvers are aided by cutting tools, moved by machinery which turns them around at the rate of fifteen hundred revolutions a minute.

40. FLOOR COVERINGS

IT is a long way from the dirt floor covered with leaves, grass, rushes, or the skins of wild beasts to the beautiful carpets and rugs to-day. Just when man began to make rugs is not known; but there are pictures of weavers at work on the stone walls of the tomb of Beni Hassan in Egypt, and we know that those pictures were cut more than forty-five hundred years ago. The ancient Egyptians spread rugs before the images of their gods, and it is said they sometimes laid them down on the ground for their sacred cattle to lie on.

Alexander the Great had splendid carpets, and he found such carpets in use during his march through Asia to India. For a long time the finest rugs of the world were woven in Persia, Turkey, and Syria; and to-day the most costly ones are some which were made in those lands long, long ago. We have old Persian rugs which sell for a thousand dollars and upwards apiece; and some fine silk ones, beautifully woven, have brought as much as twenty-five thousand dollars. Those old rugs were all woven by hand, and the best of them took many months in their making. They are composed of fine wool or silk, and have colors and tints which we cannot make now.

It was during the Crusades that the art of rug making

was carried from Turkey to Europe; and at that time the noble ladies of England, France, and other countries made carpets and tapestry wall-hangings with their needles and upon their rude looms.

Later factories were started, and Belgium began to make Brussels carpet, the name coming from the city of Brussels. Some of the Belgian weavers went to England and settled at Bristol, where they made Bristol carpet, and in 1745 some French weavers established a factory at Wilton,



Persians weaving rugs.

England, and began to make a carpet like that we now know as Wilton.

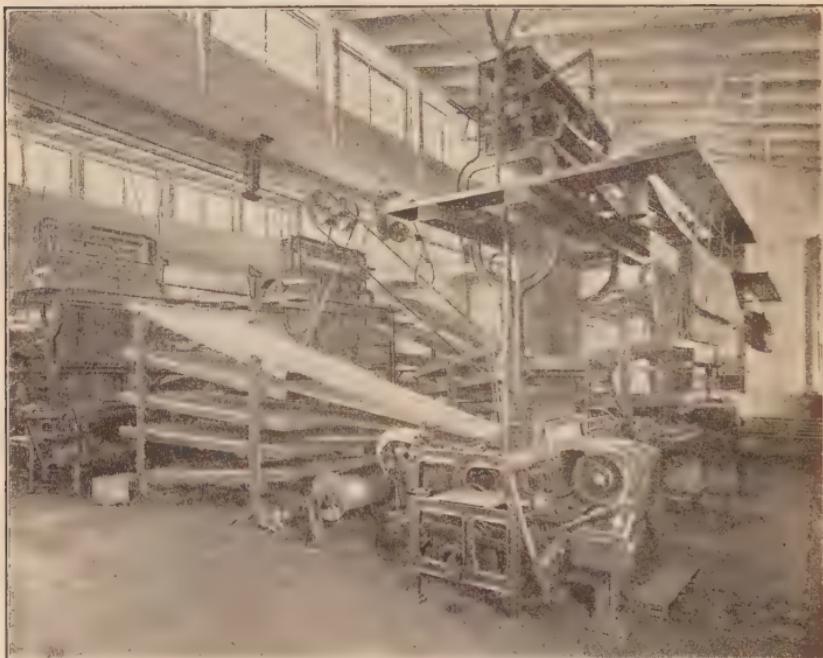
All these first carpets were costly. They were woven largely by hand, and only the rich could afford them. In colony times most of our houses had bare floors, or carpets woven of old rags torn into strips. The strips were sewed end to end, and then woven on rude looms by the women of the family. A few of our wealthy people had Turkish rugs and ingrain carpets which had been imported, but these were so rare that the children were often warned to walk lightly when upon special occasions they were admitted to the carpeted room.



Arabian rug merchant.

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After the Jacquard loom was invented in 1801, carpets grew cheaper. Many other improvements in weaving machinery followed, and we now make all kinds of carpets and rugs at a very low cost. We have enormous factories which weave nothing else. There is one at



Making carpets.

Yonkers, New York, that has one thousand looms run by machinery, and turns out as much as fifteen million yards of carpet a year. This would be enough to cover a walk six or seven feet wide, from where the factory stands clear across the United States to San Francisco. The factory employs five thousand hands, and two thirds of these are women and girls.

But this is only one factory, and we have so many others that we make altogether more than one hundred million yards of carpet a year. We weave all sorts of rugs, and carpets are now so cheap that even the poorest can use more or less of them. We import also



In a Japanese home.

many rugs of cotton and jute from Japan, where such things are made at low cost. We also buy fine old rugs from the Orient, some of which, although used for years, are more beautiful than any now made.

In addition to these floor coverings of wool, silk, and cotton, we have mattings made of a straw which grows in China and Japan. The straw is a sort of grass or reed which reaches a height of six feet. When it is ripe it is cut, dried, and packed up in bales, and shipped to

the factories. It is there sorted and the freshest and greenest of the straws are taken for the white parts of the matting, while the rest is put aside to be dyed. The matting is woven like cloth, and much of it upon hand looms, operated by children. During a visit to a Japanese factory I saw some little ones of eight and ten years of age working at the machines, and I was told that they



Matting store in Japan.

were paid only a few cents a day. Such matting is put up in rolls of forty yards each, and tightly packed for shipment across the Pacific Ocean to the United States.

Other mattings are made of the husk of the coconut. The nuts as we buy them in the store have been shelled, much as we shell black walnuts. Around each nut as it

falls from the tree is a husk as thick as your finger, and composed of a coarse fiber, known to commerce as coir. It is from this that coir matting is made. The husks are soaked in water until they are soft, and the fiber is beaten out with hard wooden clubs. It can now be twisted into a yarn by rolling it between the palms of the hands, and this yarn can be reeled upon bobbins and woven by looms into mats. Such matting is coarse and durable. It is commonly used for offices and for halls and stairs which have very hard wear.

In addition to carpets and mattings we have certain floor coverings which are more or less waterproof. They are used for bathrooms, kitchens, and other such places. Among them are oilcloth and linoleum, made by passing a sheet of cheap fiber through liquid glue, rye flour, tapioca, or varnish, and then covering it with a mixture of ocher, linseed oil, and benzine. After this the oilcloth is printed by means of blocks, each of which gives one of the colors of the pattern. The cloth is then dried and varnished, after which it is trimmed and rolled up for the market.

Linoleum is usually made of cork and linseed oil, to which are added a little resin and pigments of various kinds. The cork is the waste from the factories which make corks for bottles, the waste being ground into flour. In the meantime the light cotton cloth, which forms the base of the linoleum, has been covered with layers of boiled linseed oil. It is upon these that the ground cork mixed with resin and oil is spread, the whole being rolled upon a backing of jute. The printing is done in the same way as upon oilcloth.

As we stop and think of the many places from which even the most common things in our homes come, we are amazed at their number and at their wide distances apart upon the face of the globe. They involve the work of nearly every nation and tribe upon this big round earth, giving employment to millions of our world brothers and sisters, and binding us to them through commerce and industry as they relate to our shelter. Take, for instance, the materials which lie right under our feet, that we have been considering to-day. How many long journeys it would require to visit the places from whence they came, and to get well acquainted with the many queer people who have had a part in their making. The study of carpets would involve travels to all the wool-raising regions and also to the homes and factories in which the carpets are made. In the United States we annually make enough carpet to form a strip reaching twice around the globe, requiring hundreds of factories and thousands of looms.

A study of matting would necessitate travels clear around the world; and an investigation of oilcloths would take us to the cork forests of Spain, the flax lands of India, and to the places whence come the resin, tapioca, benzine, and the other things used in their making. It would be the same with almost every article as relates to our shelter, and it would be an impossibility for us to cover them all.

We must therefore be satisfied with having considered the main branches in this great field of industry and commerce, and our travels shall now come to an end. This does not mean that we have seen all concerning them that the world has to show. We might further investigate the wonders of our furniture, visiting the works from which

come the china we have on our tables, the pianos and organs which give us music, the pictures and other art works on our walls, and the books which form such a necessary part of our lives. We might go abroad to examine the various kinds of architecture as shown in the mighty cathedrals and other structures of Europe, and look further into the home life of our little brothers and sisters of far-away lands.

All these things would be interesting; but they are by no means essential to this series of travels as to "How the World is Housed" and they may be left to our leisure at some time in the future.

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